DEVELOPMENT OF LUMINESCENCE TESTS TO IDENTIFY IRRADIATED FOODS

Progress Report 2: Project N384

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CONTENTS

FIGURES AND DIAGRAMS

1. INTRODUCTION

This is the second report of progress on project N384, aimed at developing luminescence tests to identify and quantify radiation treatments to diverse foodstuffs.

The first report (Sanderson and Slater,1988a) concentrated on the thermoluminescence signals from whole samples of herbs, spices and seasoning mixes. Approximately 94% success was achieved in separating irradiated samples from blanks. It was also shown that the TL signal originates, not from the major organic components of the sample, but from inorganic components in or on the sample. Development of a combined PTTL/PSL instrument had started.

In January 1988 we took part in an interlaboratory study organised by the Neuherberg Institut fur Strahlenhygiene. The results are mentioned briefly in section 2. Section 3 describes an attempt to improve the discrimination of the test by renormalising the whole sample data to the ash content of the samples. The emphasis of the work reported here has been on developing and justifying density separation techniques for unambiguous TL identification of irradiated herbs and spices. In addition it has been confirmed that the technique can be applied to vegetables and fruit. Analysis of TL stability has continued and remains an important part of the study. The growth characteristics of TL (ie dose responses) from appropriate mineral samples have been studied. This work is described in sections 4 & 5. Section 6 describes the progress made with preparing instrumentation for optical stimulation, which will form the major focus for the next phase of the project. Section 7 summarises the conclusions from this phase, and gives a forward view of the immediate priorities for subsequent stages. Finally an update of sample credentials and experimental details is appended.

2. ISH INTERCOMPARISON.

SURRC took part in the second interlaboratory study of methods for rapid identification of irradiated herbs and spices organised by Dr. Lydia Heide of the Neuherberg Institut fur Strahlenhygiene. A copy of the report of our measurements has already been submitted (Sanderson and Slater,1988b) but the results are summarised briefly here.

Five examples of nine different spices and dried foods were received, together with the information that each group of five contained at least one sample irradiated to 10kGy and one unirradiated sample. As an aid to comparability with the ISH published data, four standard samples were enclosed, together with their TL intensities, measured at ISH Neuherberg.

Measurements were undertaken using the whole sample procedure described in section 2.2 of Report 1. Since our own reference set had shown that only 94% of samples could be expected to be identified using TL signal strength alone as an indicator, supplementary measurements of sample sensitivity were taken, and consideration given to the form of the glow shape as an indicator of recent irradiation. Second aliquots of all samples were taken and given an additional 10 kGy dose in the SURRC 200 TBq Co-60 source three days before readout.

We had 100% success in identifying those samples which had been irradiated before receipt, but we believe that this success depended on the availability of a calibrated source for renormalisation. In some cases it is very easy to identify irradiated samples based simply on their TL intensity as received. There are however other problematic cases where the additional information of the TL sensitivity of irradiated aliquots, and glow shape is needed. It is not clear whether the choice of samples for this study was also a contributory factor to our success in out-performing our own reference set.

The results of the intercomparison were presented at the XIXth annual meeting of the European Society of Nuclear Methods in Agriculture held in Vienna 29 Aug.- 2 Sep. 1988 (Heide and Bogl,1988). The contributors whose judgements were based on ISH reference data, compared estimates of mean and standard deviations of TL strength based on triplicate, or quintuplicate analyses with a threshold signal level on which to base their choices. All contributors identified the irradiated samples as being separated from the threshold by a scaling factor of 2 from the highest observation. However ambiguities crept in between 3 and 4 times the highest result. We are somewhat cautious in accepting the statistical basis of this procedure as a robust indicator, to be used for statutory control, although this is currently proposed for Germany.

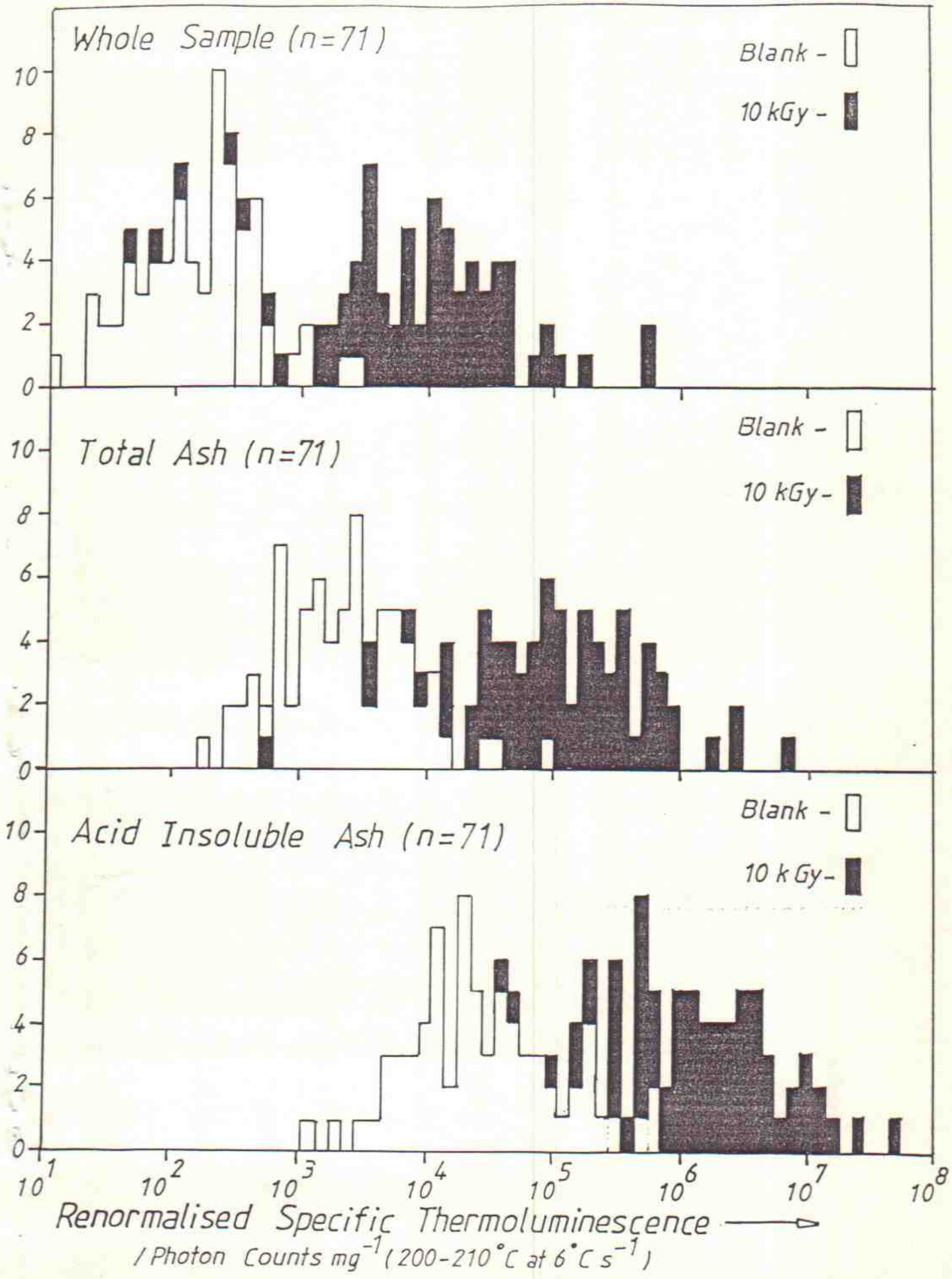
3. IMPROVING DISCRIMINATION.

Although 94% discrimination is a promising start the level of confidence needed for legislative support is rather greater. A series of experiments was conducted to improve the discriminating power of TL measurements by isolating selected sources of signal variance. The need for experimental simplicity was born in mind, and therefore the measurement process was refined sequentially until the major sources of sample variance had been isolated.

The postulated sources of variance in whole sample measurements were : (i) variance in quantity of luminescence material, (ii) variance in the TL sensitivity of the luminescent phase(s), (iii) variance in the dose response (ie saturation levels etc), (iv) spurious TL due to chemical reactions of organic material in the whole samples, and (v) variance in the residual geologically induced signals from minerals. Each of these components was expected to have a different impact on readings from irradiated samples and blanks. It was also hoped that there might be a dominant effect whose isolation would lead to a dramatic improvement in sample reproducibility and discriminating power. Reproducibility of the TL reader to pure mineral samples was known to be better than +-5% from archaeological dating work.

3.1 Renormalisation to % total ash.

The ash of a foodstuff is the inorganic residue remaining after the organic matter has been burnt away. In an attempt to keep the test simple, but to improve the discrimination, the ash content of a selection of samples of varying TL sensitivity was determined by heating a small sample (0.1-0.5g) in a silica combustion thimble to 550°C for 3-4 hours and calculating the ash content as a per cent of the initial sample mass. The TL response previously determined was renormalised to this figure and plotted in the histogram shown in figure 3.1. Improvement in discrimination can, at best, be described as marginal compared to the whole sample histogram for the same sample set. The total ash content includes a large amount of bioinorganic material and salts. A better estimate of the mineral matter present would be obtained by determining the acid insoluble ash content of the sample.



3.1 Histograms showing data renormalised to whole sample mass, % total ash and % acid insoluble ash.

3.2 Renormalisation to % acid insoluble ash.

The acid insoluble ash is a measure of the mineral debris content of food; maximum permitted levels are prescribed in US regulations (Egan, Kirk & Sawyer 1981). This was investigated in an attempt to gauge the mass of the TL sensitive phase more accurately.The samples (1-2g herbs, 3-5g spices) were ashed by heating in a preweighed, dry silica crucible to 650°C for 3 hours. The crucibles were cooled in a dessicator, reweighed and the total ash content was calculated. The ash was boiled in 10ml 1M HCl for 5 minutes, filtered through a Whatman No.42 ashless filter paper and washed with hot deionised water. The filter papers were placed in the original dish, ignited overnight, cooled in a dessicator and reweighed. The acid insoluble ash content was calculated as a per cent of the sample mass.

The TL response previously determined was renormalised to this figure and the results plotted in the histogram shown in figure 3.1. Once again,there was a minor improvement in discrimination when compared to the whole sample histogram for the same sample set, but not sufficient to make a significant difference to confidence.

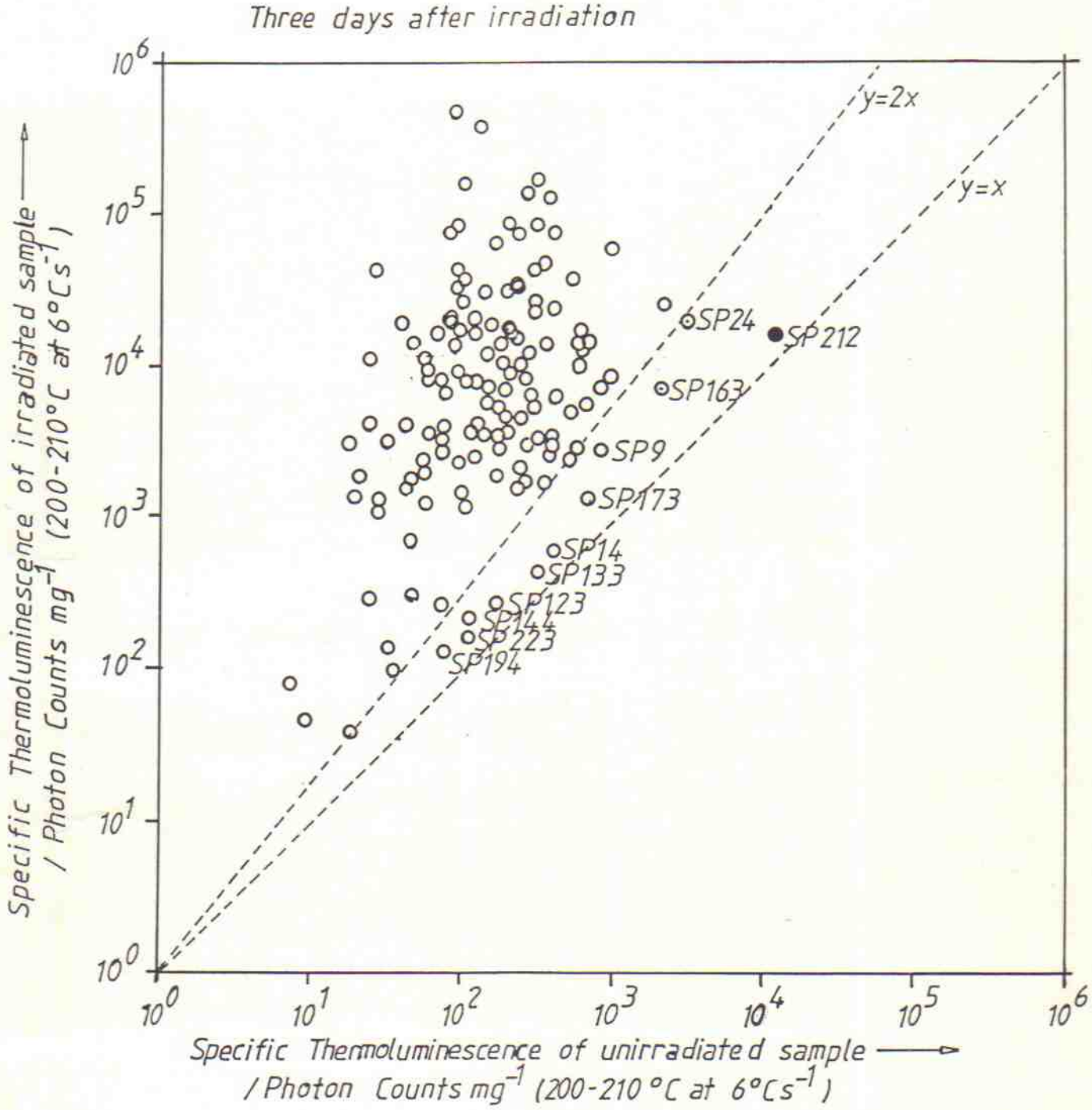
From these two sets of observations it was concluded that variance in the quantity of TL material alone could not account for the major variance of the whole sample data set.

3.3 Other approaches.

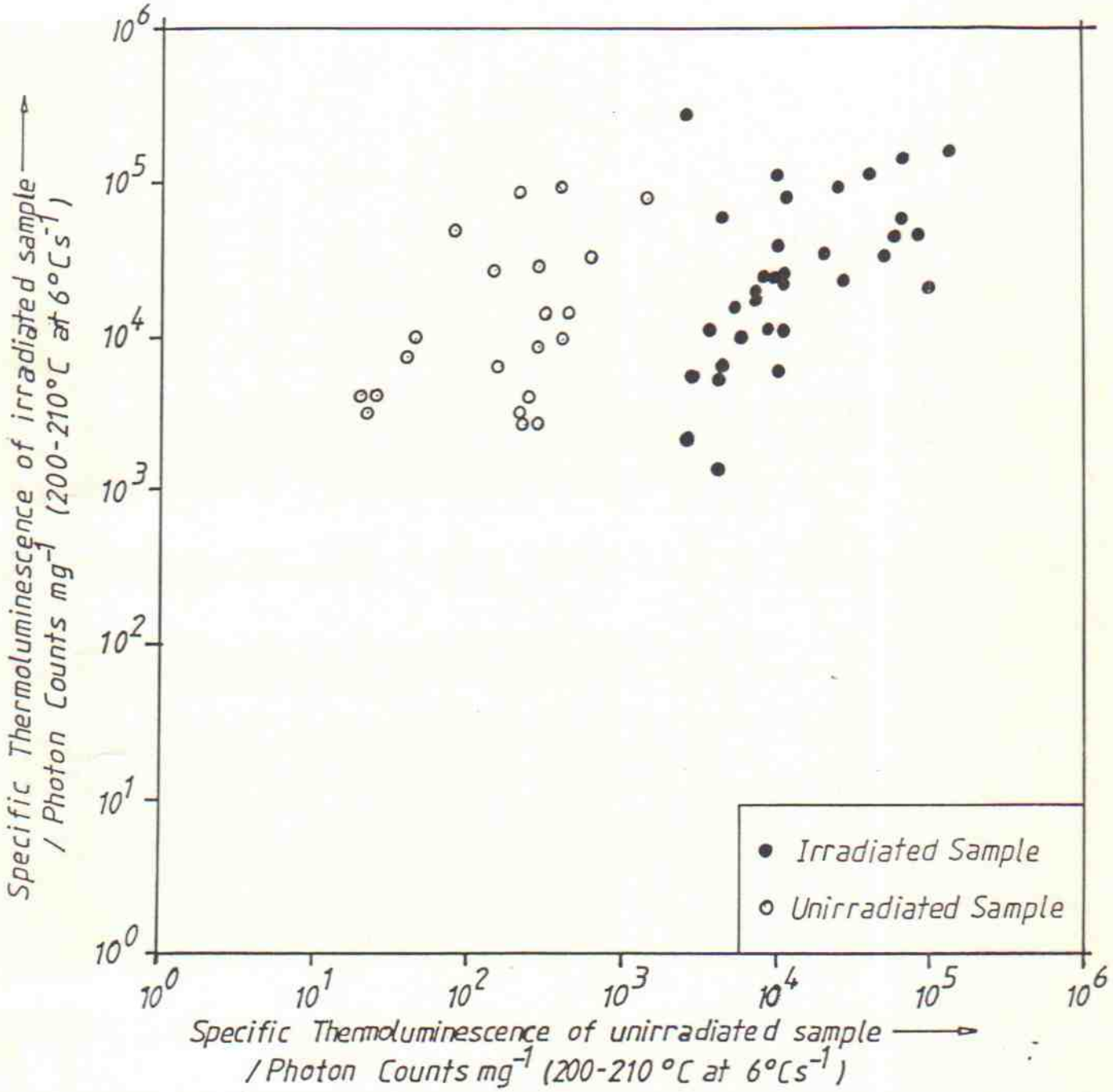
In considering whether a combined measurement of quantity of material and TL sensitivity could account for the variance a practical obstacle is encountered using whole sample measurements. This is that the readout process is destructive to the sample, and therefore re-irradiation followed by second-glow normalisation is not an option.

Estimation of sensitivity for whole samples can however be attempted by comparing the TL yields of two aliquots, one of which has been irradiated before readout, as indeed was undertaken for the ISH samples. Figures 3.2, 3.3 show the two dimensional plots of TL measured after irradiation to 10 kGy against TL as received for our own sample reference set and the ISH samples respectively. The ISH samples fall into two loci which do separate irradiated from unirradiated samples with one ambiguity - which was resolved on ground of glow shape. Of our own reference set the 2d plot correctly associates Cardamom sample SP212 with the irradiated group, but also identifies two other samples as ambiguous (SP24 and SP163) and a group of 7 samples with low light outputs as outliers from the main cluster. It seems therefore that this approach has something to offer compared with a simple threshold based whole sample analysis, but that it does not yet explain most of the variance.

3.2 Two dimensional plot comparing TL after irradiation to 10 kGy with TL as received for the SURRC reference set



3.3 Two dimensional plot comparing TL after irradiation to 10 kGy with TL as received for ISH samples.



An alternative, although more laborious approach to the problem of isolating the component which carries the TL signal is the density separation technique described in section 4.2 of Report 1. Our early experiments in refining this method are described below. One of the benefits of separated material is that it can be renormalised.

Photostimulated techniques should solve any problem of spurious signals from residual organic components of the sample. This technique will be explored further in the next phase of the project.

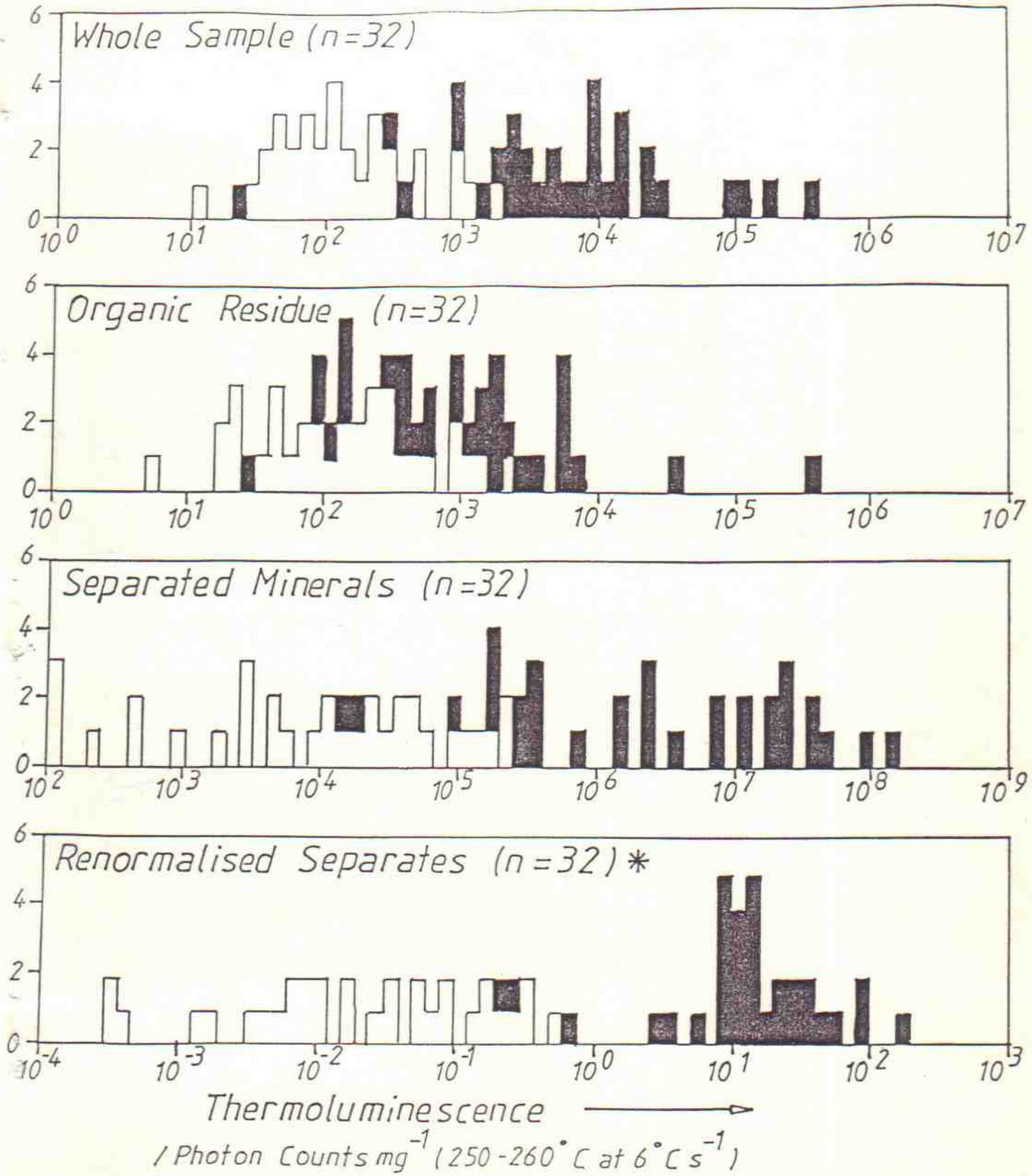
3.4 Developing the density separation technique.

Low signals from irradiated samples using whole sample methods are probably due to the variable combination of paucity, and low sensitivity, of mineral grains present on the sample. High blanks may be due either to the abundance of many mineral grains being present with a high residual geological signal, or to spurious TL from the organic component. Separation and enrichment of the mineral fraction leads to far improved measurement conditions, reduced spurious blanks and opportunities to measure sample sensitivity by re-irradiation of the sample disc.

Preliminary application and development of the method was undertaken using a subset of 32 samples of herbs and spices. They were separated into high and low density fractions as follows. A small sample (~ 100mg) was agitated in an ultrasonic bath in a solution of sodium polytungstate prepared to a density of 1.5 g cm-3 and then centrifuged to separate organic and mineral fractions. The low density layer, which floated, was decanted through a filter and the sub-milligram quantities of higher density material were then washed, resuspended in acetone, and allowed to settle onto stainless steel discs. Stokes sedimentation was used to manipulate an invisibly small amount of mineral matter handled under the subdued lighting of the TL laboratory.

After drying in a laboratory oven overnight at 55°C, irradiated samples and blanks (both subject to parallel extraction) were glowed out along with washed and dried organic residues which were dispensed onto stainless steel discs by the standard whole sample method described in section 2.2 of Report 1. Overnight drying serves both to evaporate the acetone and also to remove unstable components of the TL signal. The results of this separation are shown in figure 3.4. This shows the whole sample results, the signals from organic residues and the unnormalised results from the separates expressed as photon counts per milligram of sample at 250-260 °C. The thermoluminescence signal at this temperature should be stable for a number of years, but is short lived compared to geological timescales. A nominal mass of 0.1 mg was used for the separated minerals shown in the third histogram as there was insufficient sample to weigh on a five-figure balance.

3.4 Histograms showing early results from density separation of minerals from herbs and spices.



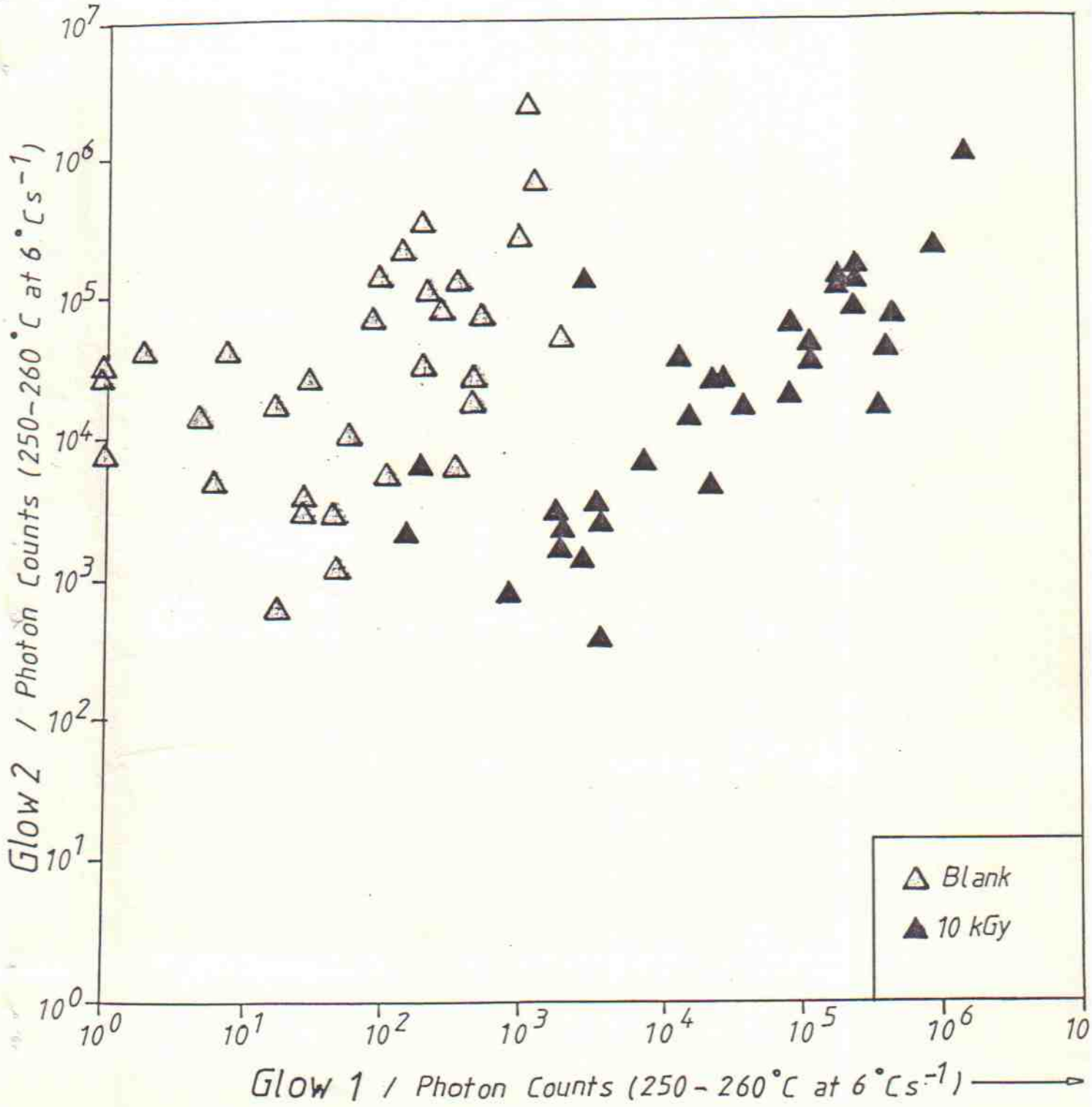
The results clearly show that the TL signal is concentrated in the mineral phase of the sample. The TL signal from irradiated samples is about three orders of magnitude greater in the separated minerals than the organic residue. Separation of the mineral phase from the organic phase was incomplete as shown by the few residue samples with counts $>10^4$. Microscopic examination of the organic residue confirmed this to be the case.

Microscopic examination of the mineral discs revealed a great variation in the number of grains on each disc. An assessment of the sample size based on a microscopic grain count score (weighting each grain by a volume sensitive factors) was correlated with sample sensitivity as measured in repeat irradiation. Nevertheless the scatter about this correlation confirmed that the TL sensitivity of individual mineral grains was highly variable. An earlier study of TL of separated alkali feldspars for archaeological dating (Sanderson, 1988) showed that specific TL for even pure feldspars varies by two orders of magnitude so this was not altogether surprising. In order to take account of this variation, a normalisation dose of 2.5 kGy was given to the mineral discs which were then glowed a second time and the ratio of the first glow to the second glow calculated. The results of this exercise are shown in the bottom histogram of figure 3.4. The scale on this histogram refers to the ratio of the first glow to the second glow, and is therefore dimensionless. Figure 3.5 shows the 2 dimensional plot of first glow versus second (normalisation) glow results for the irradiated and unirradiated sets again confirming that sensitivity variations are a significant parameter.

Some evidence of cross-contamination during the reirradiation procedure was shown by irradiated samples which had a very small signal in the first glow, but a higher signal from the second glow. This resulted in these irradiated samples lying amongst the blanks in the histogram of renormalised separates. The spread of data from the renormalised blank discs indicated that there have been a component of contamination through dust from the air (via glassware). These difficulties were not entirely unexpected in view of the extremely small sample size and the very high range of sensitivity of known materials in the laboratory environment.

Nevertheless the marked improvement in discrimination was taken to confirm that sensitivity, spurious TL and occlusion of the mineral grains when measured in whole sample form were indeed the main sources of variation.

3.5 Two dimensional plot for separated minerals from 32 herb and spice samples.



4. SEPARATED MINERALS.

4.1 Minerals separated from herbs and spices.

The next phase of the project concentrated on applying the lessons learned in the previous phase to obtain a more extensive data set.

A more extensive set of herbs and spices were separated using the method described above, but working with slightly larger samples and taking stringent extra precautions to prevent cross-contamination. These included thorough cleaning of the laboratory at the beginning and end of each day, blanking of all glassware and reagents, protecting samples against atmospheric contamination during the separation procedure, using cling film, and wrapping mineral discs in individual capsules for reirradiation.

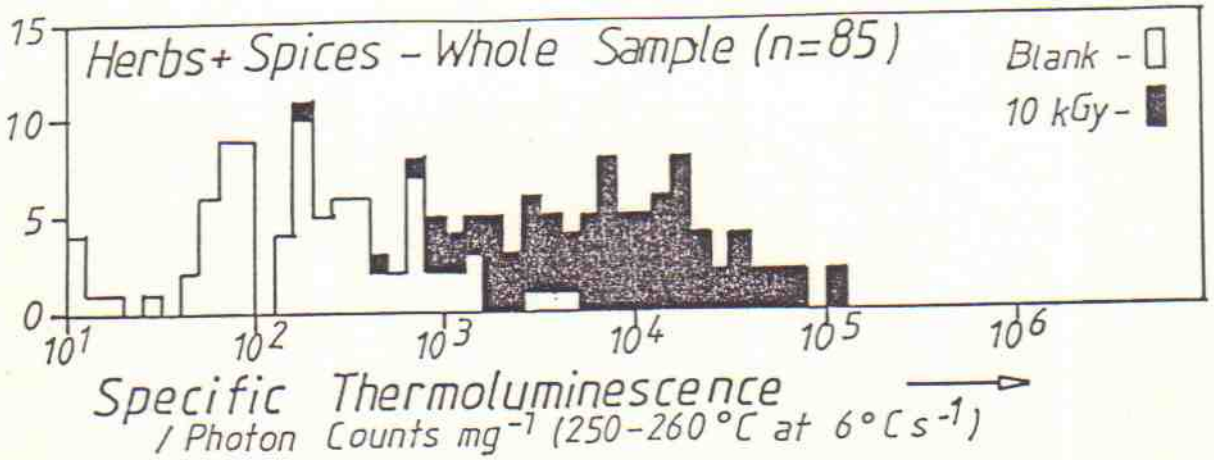
Some samples were very difficult to separate. Turmeric had a high density organic phase, which resulted in a cake of sample on the disc. This was easily dislodged during the second irradiation and the data had to be rejected for quality control reasons. Dried onions form a gel which inhibits separation when hydrated, so these samples are not suitable for separation by this procedure. Any disc which gave a count of less than 100 counts per second for an irradiated sample was rejected on the grounds that it was approaching the detection limit of the system (the dark count is approximately 50 counts per second). Microscopic examination of these discs confirmed the absence of mineral grains. One hundred and seventy good discs were prepared from eightyfive irradiated samples and their associated blanks.

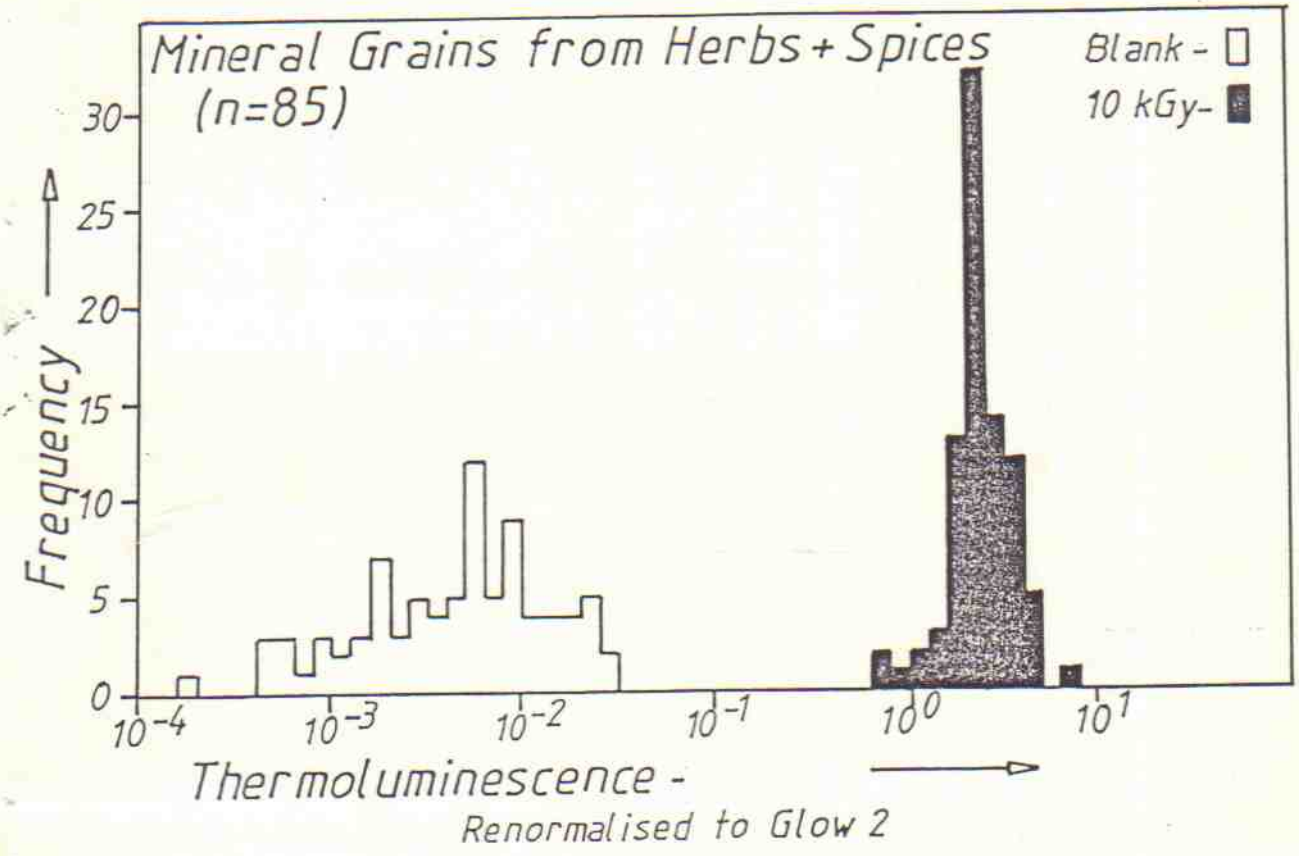
The results are shown in figure 4.1. Small variations in the mean gamma doses delivered to each batch of samples, and recorded using Harwell red-perspex dosimeters were taken into account as a minor source of variation. The scale on the x-axis is the ratio of Glow 1: Glow 2 and is therefore dimensionless. The spread of irradiated samples is confined to just over one order of magnitude. The spread of blank samples is greater, being over two orders of magnitude. Nevertheless, the blank and irradiated samples are clearly separated by more than one order of magnitude despite having started with samples which included the least promising whole samples.

Glow curves from minerals separated from previously low sensitivity samples are shown in figure 4.2 (bottom row). The top row shows the glow curves from the associated whole sample. Ground caraway has a contaminated blank. (The shape of the glow curve indicates that it has been contaminated by a recently irradiated mineral grain from the atmosphere, rather than cross-contamination from its associated 10 kGy sample.)

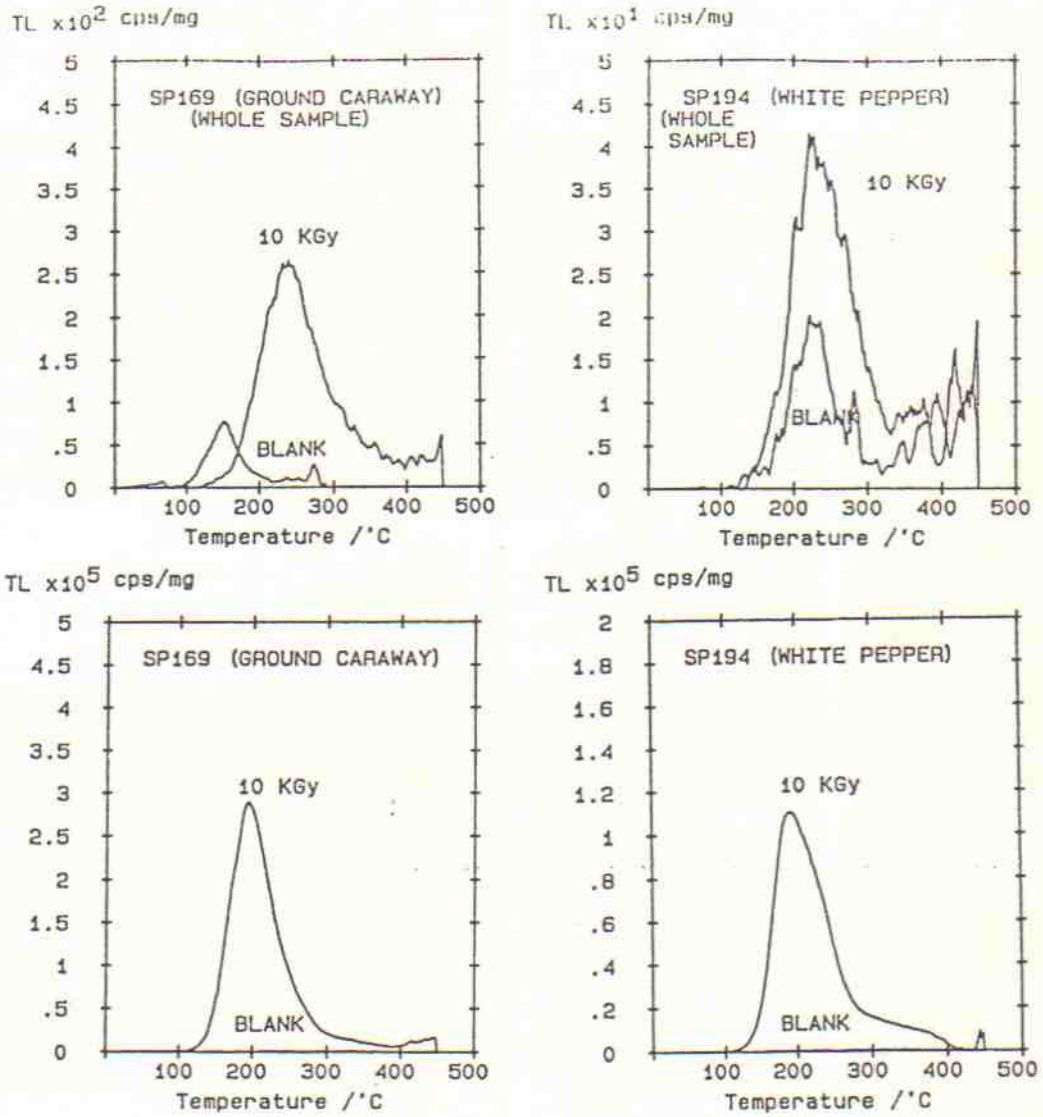
A selection of glow curves from minerals separated from various spices and herbs are shown in figures 4.3 & 4.4.

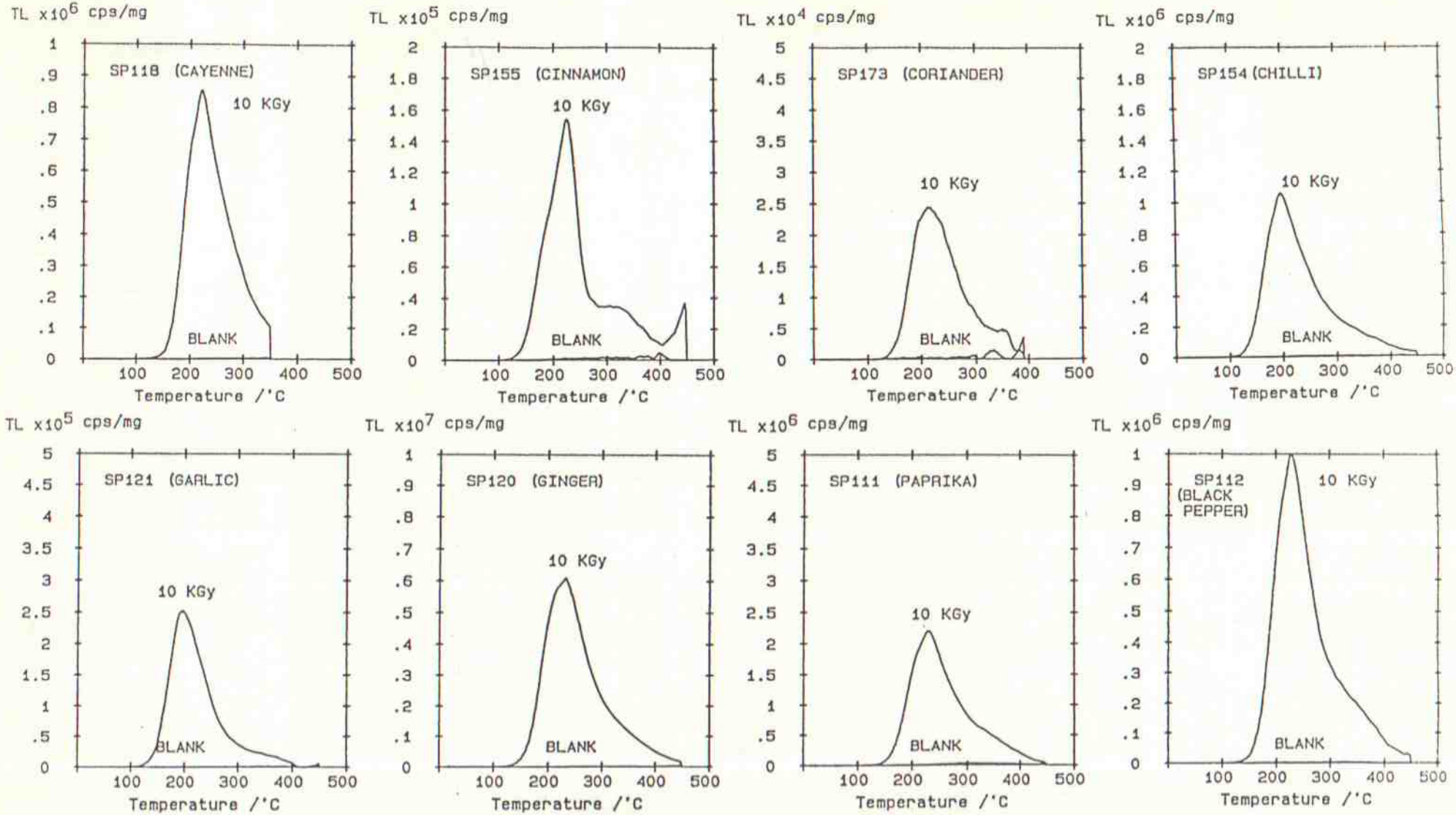
4.1 Histograms showing thermoluminescence of whole samples and mineral grains from 85 herbs and spices separated using the refined procedure.



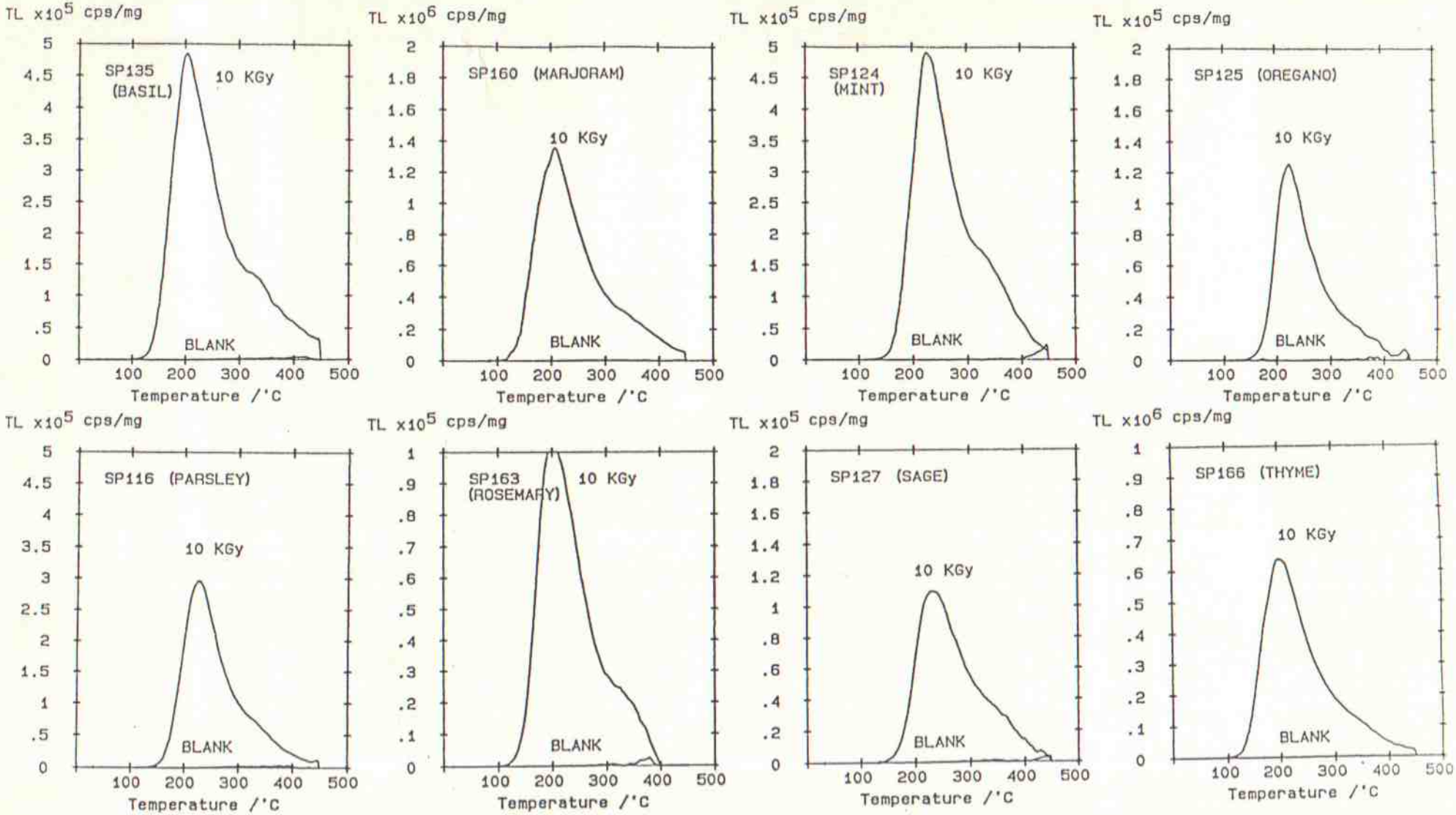


4.2 Glow curves from previously low sensitivity samples (top row) and minerals separated from these samples (bottom row).





4.3 Glow curves from minerals separated from various spices.



4.4 Glow curves from minerals separated from various herbs.

The dramatic improvement in discrimination demonstrated in these experiments has a number of implications. Samples which had previously shown diverse properties ranging over many orders of magnitude have now been united in their behaviour, by isolating the common component which carries the TL signal. The results appear now to be drawn from two statistical distributions (one for blanks and one for the sensitivity) which define the discriminating power independently of sample type. The confidence intervals attributable to judgements for unknown samples remain to be defined (should log-normal statistics be used ?) , but nevertheless promise unambiguous discrimination and identification of recently irradiated materials.

Although the separation method is laborious and demanding, there are no reasons why the inherent sample handling difficulties cannot be adequately dealt with by replication, frequent blank measurements and good quality control procedures. We are now in a position to specify the requirements for a routine test based on this process.

The separation procedure described depends on the use of sodium polytungstate, which is an expensive reagent, and therefore must be recycled for routine use. This was done by triple filtration followed by reconcentration. Unfortunately some samples seem to interact with the sodium polytungstate and whilst it does not lose its high density properties, it does change colour and acquires an unpleasant odour, limiting the number of times it can be recycled. Because of the expense and limited lifetime it would be desirable to substitute an alternative heavy liquid. We are currently looking at some possible substitutes , including Calcium Chloride:hexahydrate which can be made up to 1.4 g cm^{-3}. For the time being however the polytungstate remains our established working solution.

4.2 Minerals separated from avocado pears.

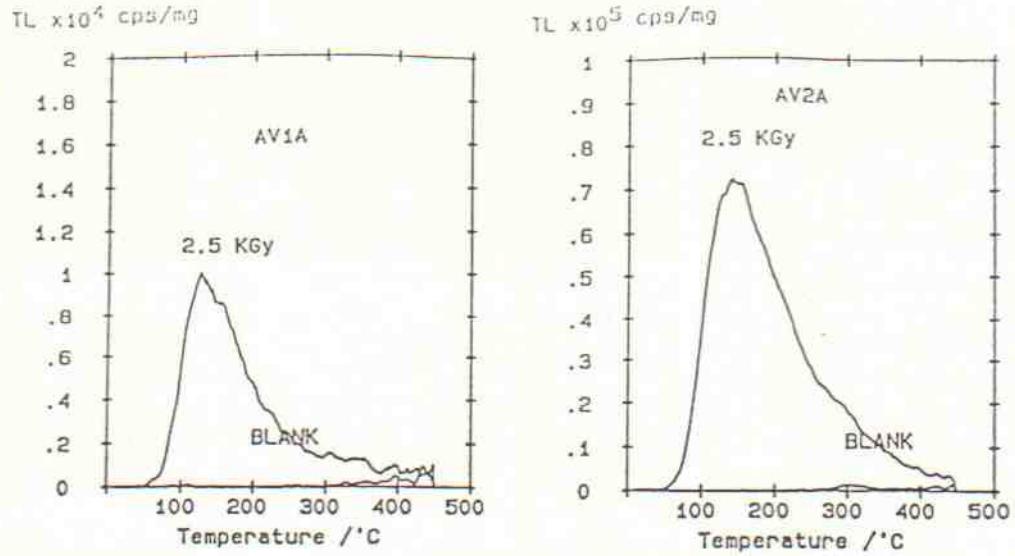
Having unified the TL behaviour of herbs and spices the extension to a wider variety of fruits and vegetables seems a firm possibility. This has been explored to some extent.

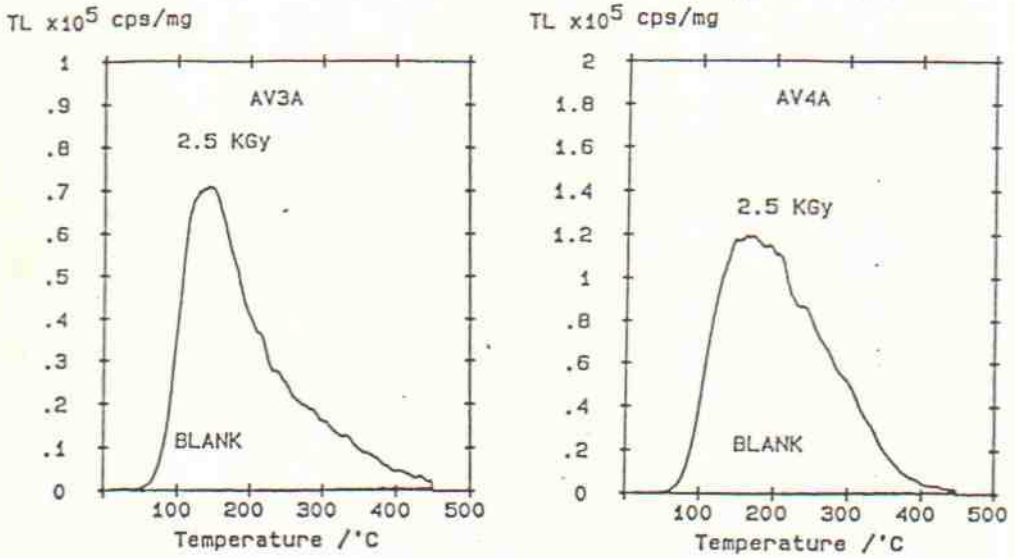
Avocado pears may be a suitable candidate for irradiation preservation since they are a high value product, many of which are imported from countries which have irradiation capabilities, including Israel and South Africa. Delaying ripening by irradiation would have obvious benefits.

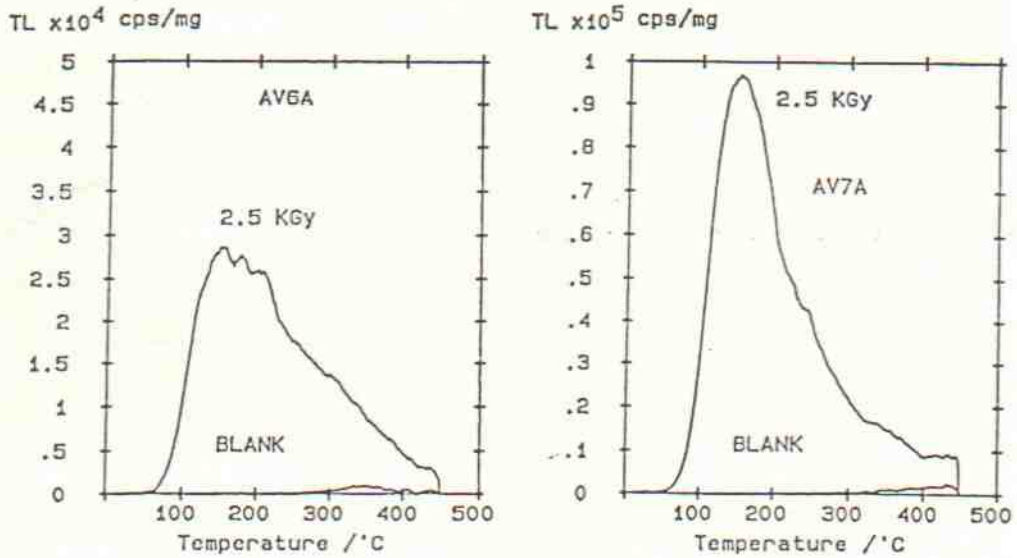
A selection of avocado pears were purchased from local outlets. The details of these are described in Appendix A. Five of the seven outlets sampled were selling avocado pears imported from Israel, one from South Africa.

The density separation technique employed for herbs and spices was scaled up for use with fruit and vegetables. Deionised water was used in place of a high density liquid and 600 ml glass beakers were employed instead of test tubes. The beakers were covered with 'cling film' to prevent contamination from the atmosphere. Special precautions were taken to ensure the glassware was clean before use. These are described in Appendix D. Two sample discs were prepared from each avocado pear. A decision was taken to irradiate sample discs with separated minerals rather than the whole fruit to ensure a uniform dose for each sample. The first disc was irradiated for 1 hour prior to glowing, equivalent to a dose of 2 kGy. The second was glowed immediately. All discs were given a 2 kGy normalisation dose. The ratio of the first glow to the second glow was taken using the ten degree ordinate from 250-260oC. The results are shown in figures 4.5. The glow curves have the same shape as minerals separated from herbs and spices.

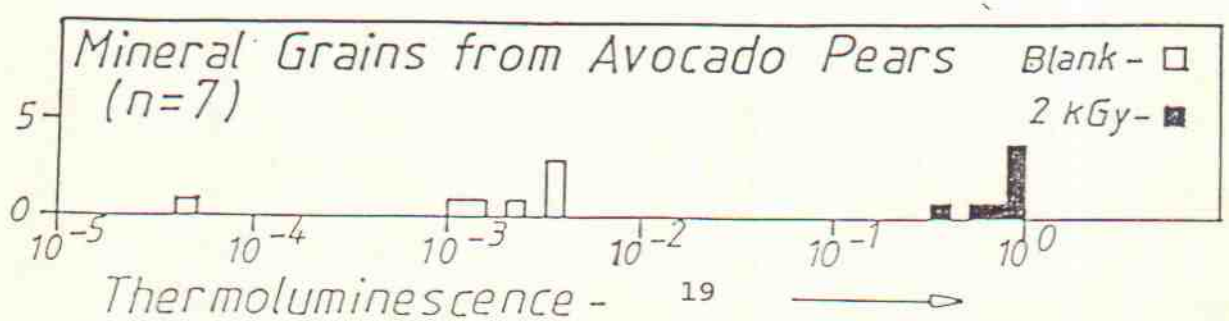
None of the avocado pears had been irradiated when purchased. Two orders of magnitude separate the irradiated samples from the blanks. This method should be applicable to all fruit and vegetables.







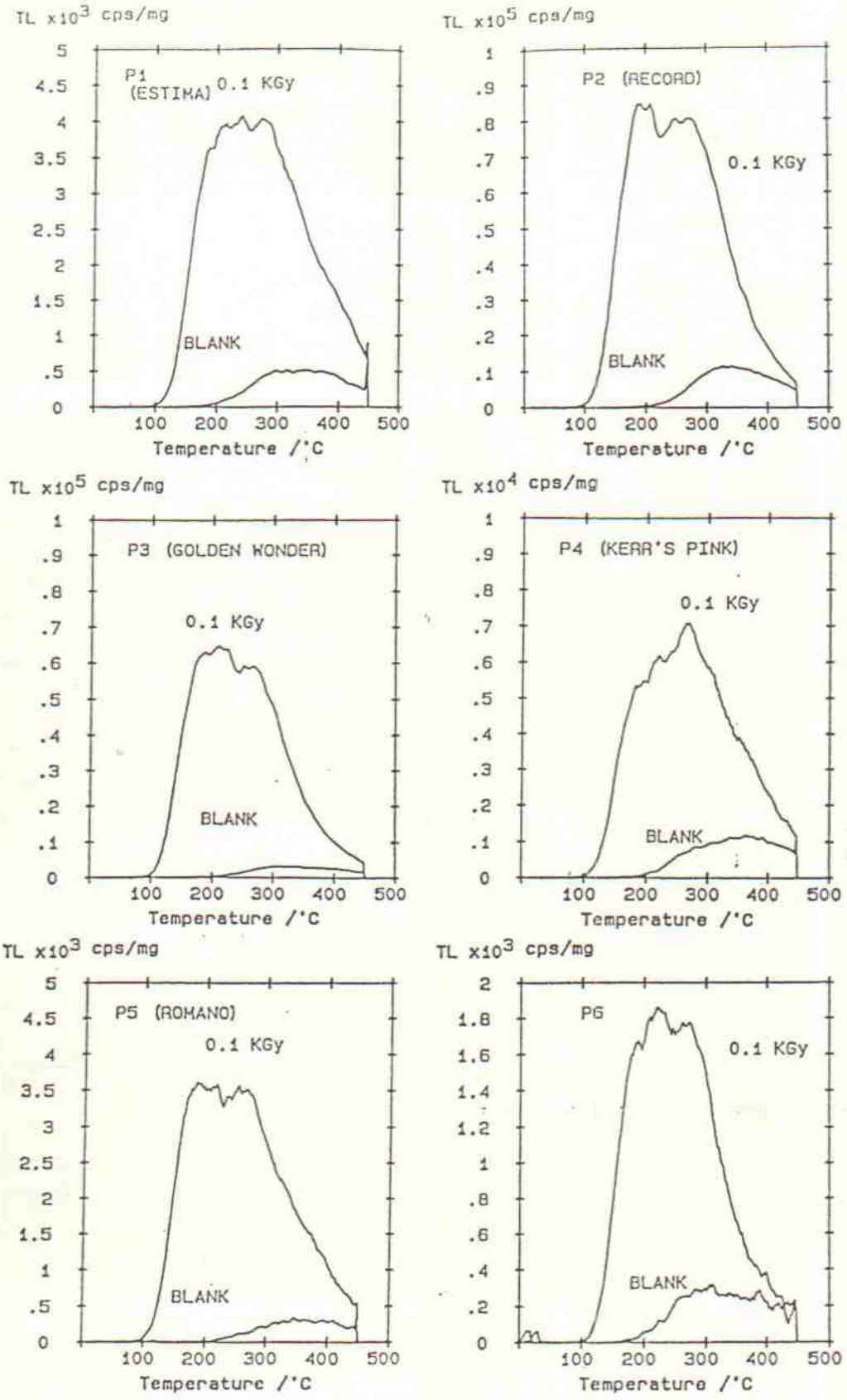
4.5 Results from minerals separated from avocado pears.



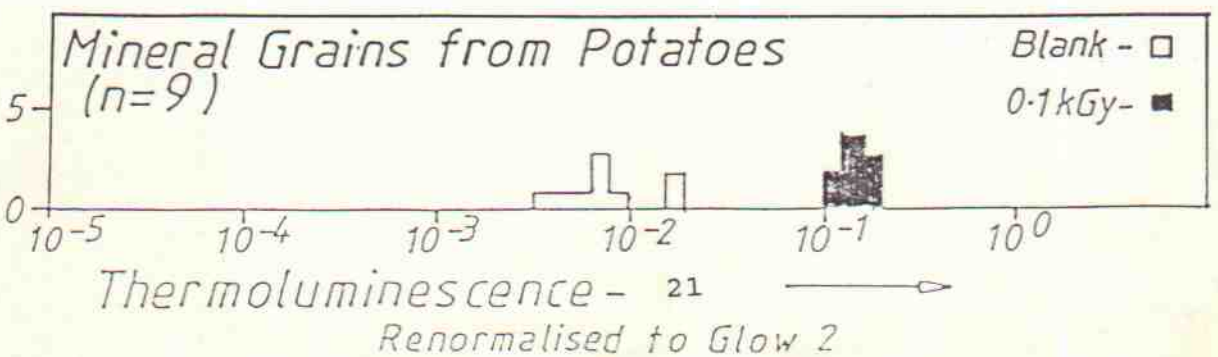
4.3 Minerals separated from potatoes.

Very few mineral grains per disc were obtained from avocado pears and the number per disc from herbs and spices varied from none to very many. Potatoes were used in order to achieve a more even distribution of grains from a food sample. From earlier experiments, it was known that the density separation technique could be adopted.

Six different varieties of potato were purchased from a local supermarket. These are described in Appendix A. The separation technique described above was adopted.
Four discs were prepared from each sample. Half of the discs were irradiated for 3 minutes in the Co-60 source (0.1 kGy). A 1 kGy normalisation dose was administered after the first glow. The results are shown in figure 4.6. Some discs had to be rejected due to loss of sample during the reirradiation procedure. Many unirradiated potato discs had a significant geological signal compared with the 0.1 kGy additional dose, although the glow shape differences can be exploited to distinguish this from a recent event. Again, there was no doubt about which samples had been irradiated and which not.



4.6 Results from minerals separated from various varieties of potato.



5. Additional Characteristics.

5.1 Growth of thermoluminescence from 0.1-33 kGy.

Three types of sample were selected to study the growth of thermoluminescence at food processing doses. The first was a pure sample of microcline feldspar (fine grains), the second was a sample of soil collected from an archaeological site, and the third was mineral grains separated from a food sample, namely potatoes.

The soil sample was dried and sieved through a 1 mm mesh. Both the soil and feldspar samples were annealed at 400°C for 5 minutes and dispensed onto stainless discs using silicone grease as a contact lubricant. A concentrated suspension in acetone of fine-medium mineral grains from potatoes was prepared. Eighteen stainless steel discs were prepared by dispensing 1 ml of this suspension onto each disc and drying overnight in a laboratory oven. Duplicate discs of each sample were irradiated and stored in a dark cupboard, at room temperature, for three days prior to glowing. A normalisation dose of 1 kGy was administered, followed by a pre-heat at 110°C for 15 minutes prior to the second glow. The results are plotted in figure 5.1.

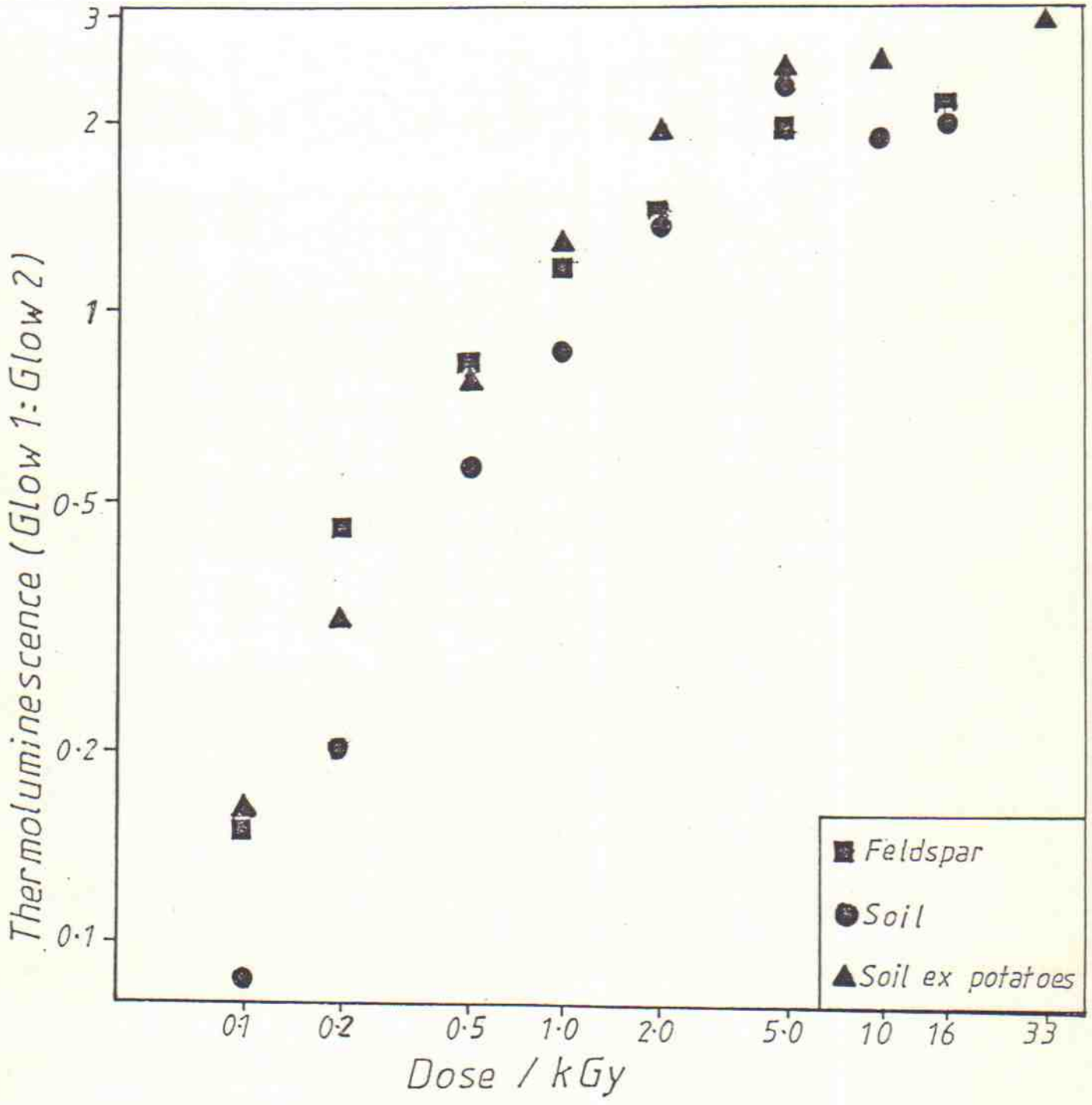
5.2 Stability of thermoluminescence signals.

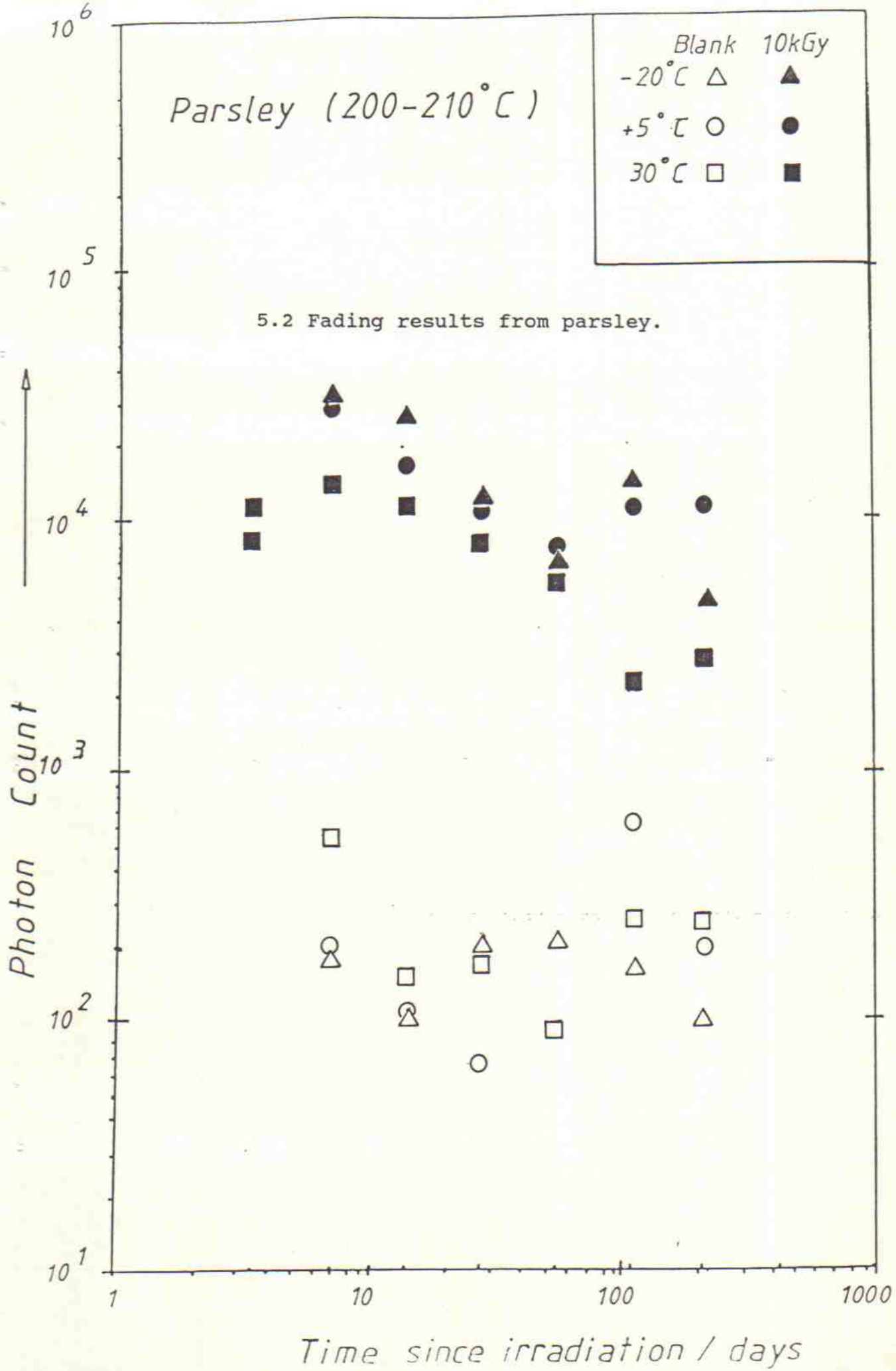
The samples selected for stability tests under controlled storage conditions, and whose preliminary results were reported in section 3.3 of Report 1 have now been in store for over eight months. Updated diagrams are presented in figures 5.2-5.5. The parsley, cinnamon and chicken seasoning signals have held up well, but only the ginger stored at chilled temperatures has maintained its signal above the ambiguous zone. The improved discrimination of separated materials, and the choice of a higher glow curve temperature should help here.

Of the 12 samples selected for full fading analysis,
three were seasoning mixes containing salt as a major ingredient. These have unambiguous and reproducible results of which chicken seasoning is typical. The signal to background ratio after eight months is still of the order of 10,000 (fig. 5.5); therefore we are confident that dry irradiated products containing salt will be identifiable by the simple whole sample method many years after irradiation, provided the packaging protects the product from light.

The irradiated herb and spice samples, except ginger and onion powder, have maintained strong signals except at 55°C. Fig.5.3 shows a cinnamon sample from an earlier batch, but is typical of the results obtained. When this batch was put into store, the 55° incubator was not available. Fig. 5.2 shows the results of a parsley sample using the glow ordinate range from 200-210°C as before. If the ordinate from 350-360°C for the same sample is plotted the results can be seen in fig.5.6. The signal to background ratio is not as great, but the signal is more stable,

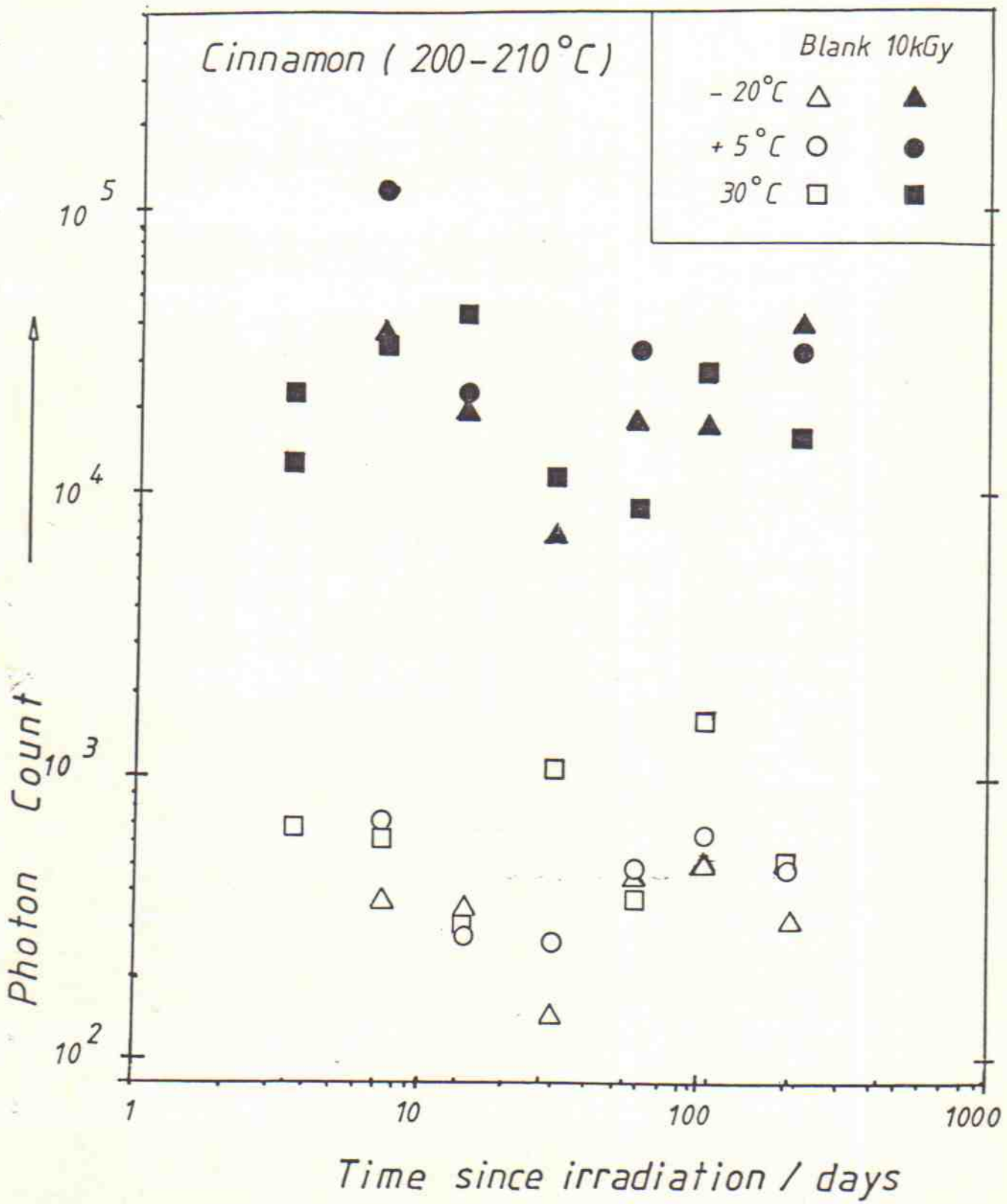
5.1 TL growth curve.



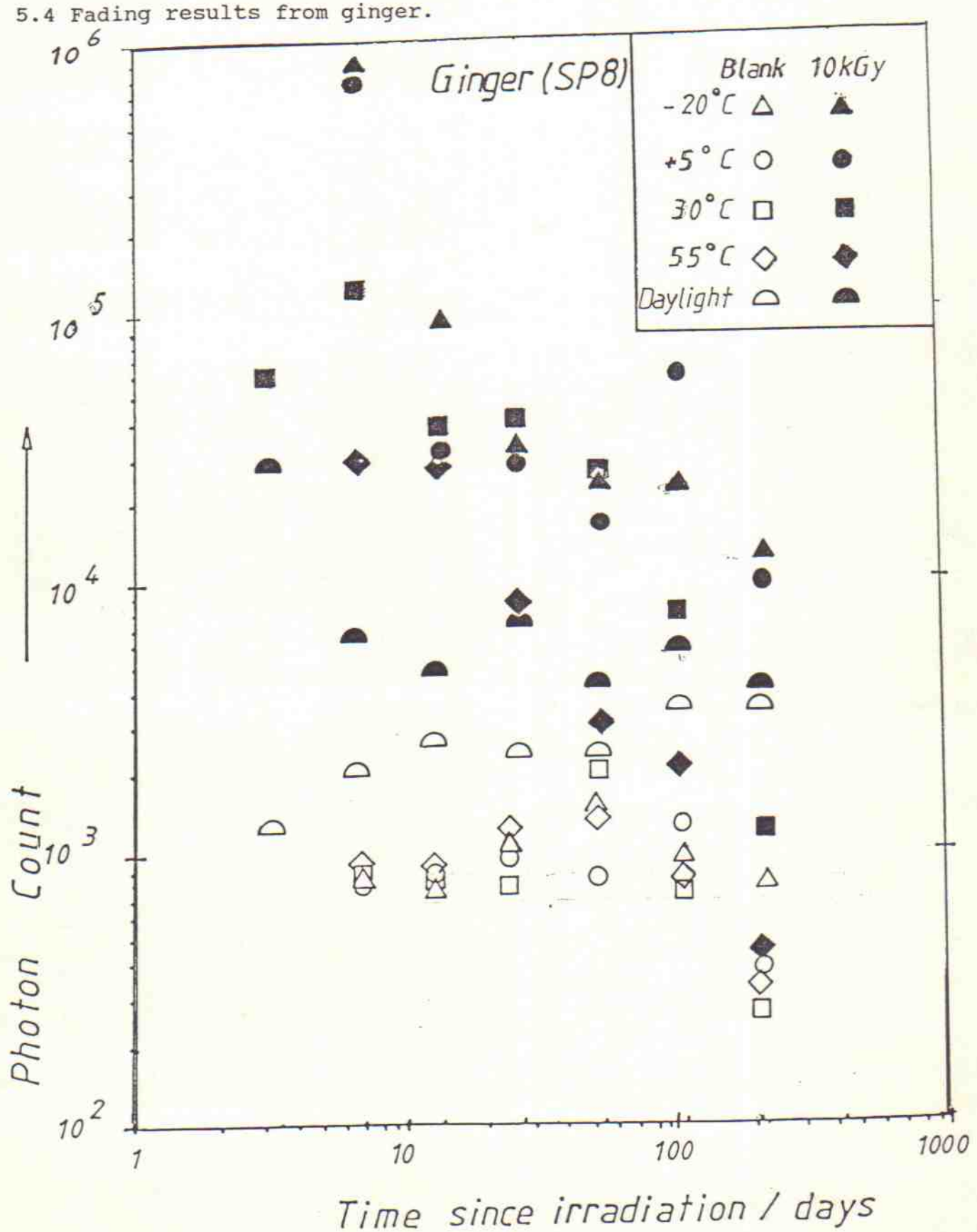


5.2 Fading results from parsley.

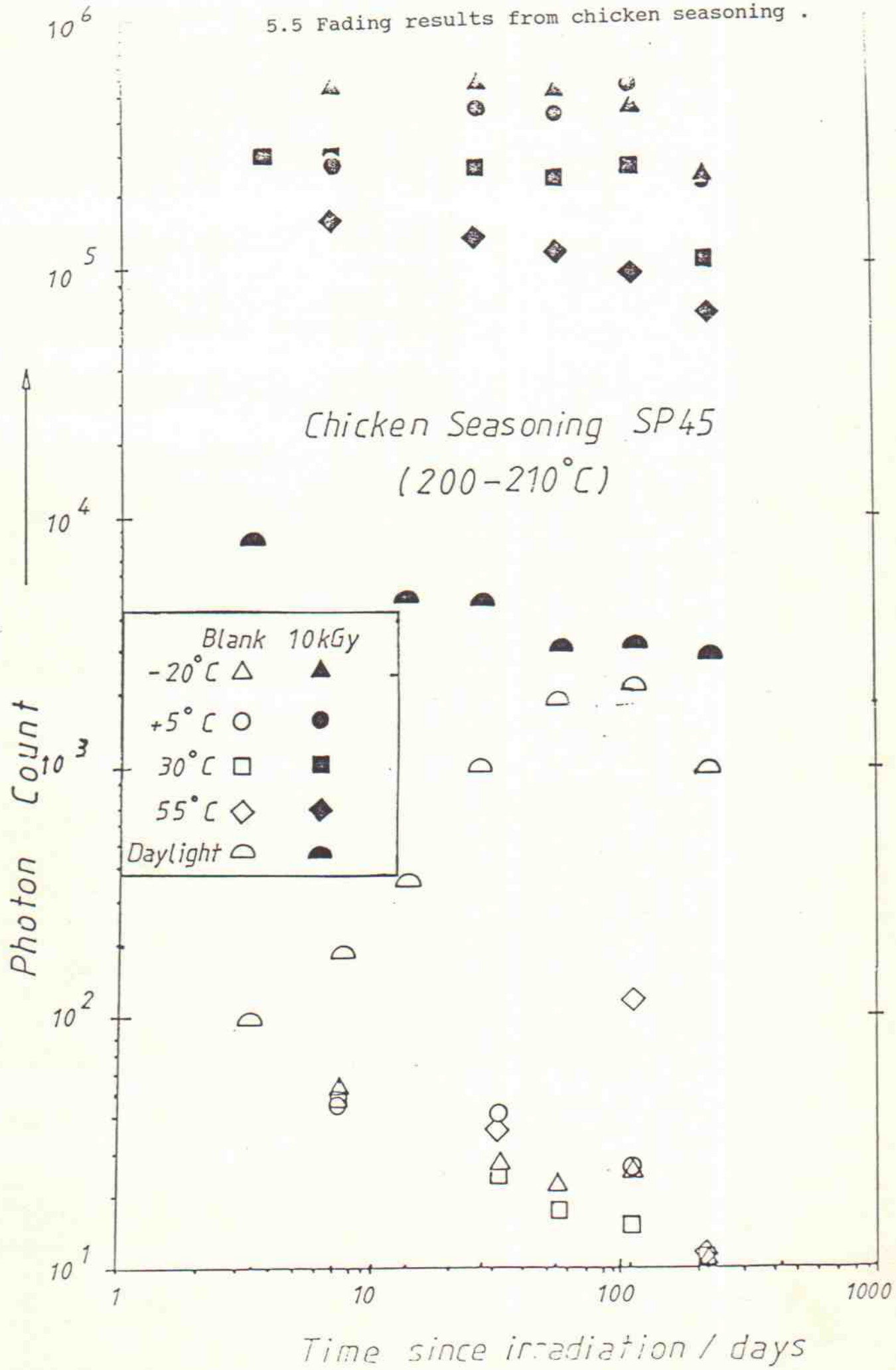
5.3 Fading results from cinnamon .

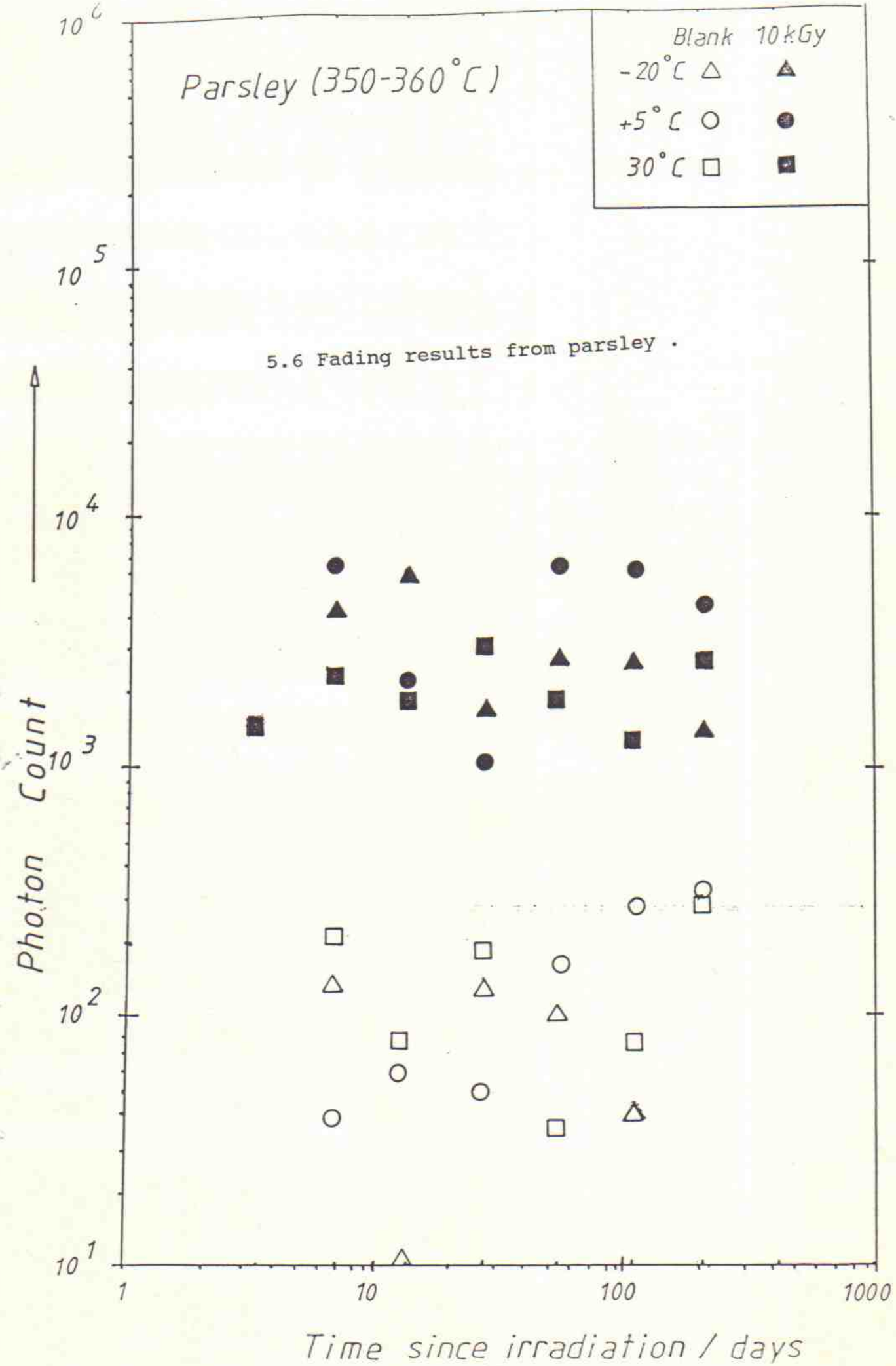


5.4 Fading results from ginger.



5.5 Fading results from chicken seasoning .





5.6 Fading results from parsley .

reflecting the sampling of traps with higher thermal activation energies. Reproducibility of these measurements is limited for all herbs and spices due to the heterogeneous nature of whole samples.

5.3 Bleaching of the TL signal by daylight.

Aliquots of the same 12 samples which were selected for full fading analysis were irradiated to 10 kGy at the end of March 1988. These, together with their associated blanks, were placed in small plastic petri dishes on the laboratory window sill immediately after irradiation. The TL signal was measured on a logarithmic time scale beginning three days after irradiation. The samples have now been exposed to daylight for over eight months.

The results are shown for ginger in figure 5.4 and for chicken seasoning in figure 5.5. In both cases the signals were bleached within the fist two weeks to what seems to be a stable plateau. The blank levels have also risen systematically for reasons which are not yet clear, but may include phototransfer of the geological signal from deeper traps. The colour and flavour also faded rapidly over the same time period, so that if samples were stored under these conditions, they would have a significantly reduced market value.

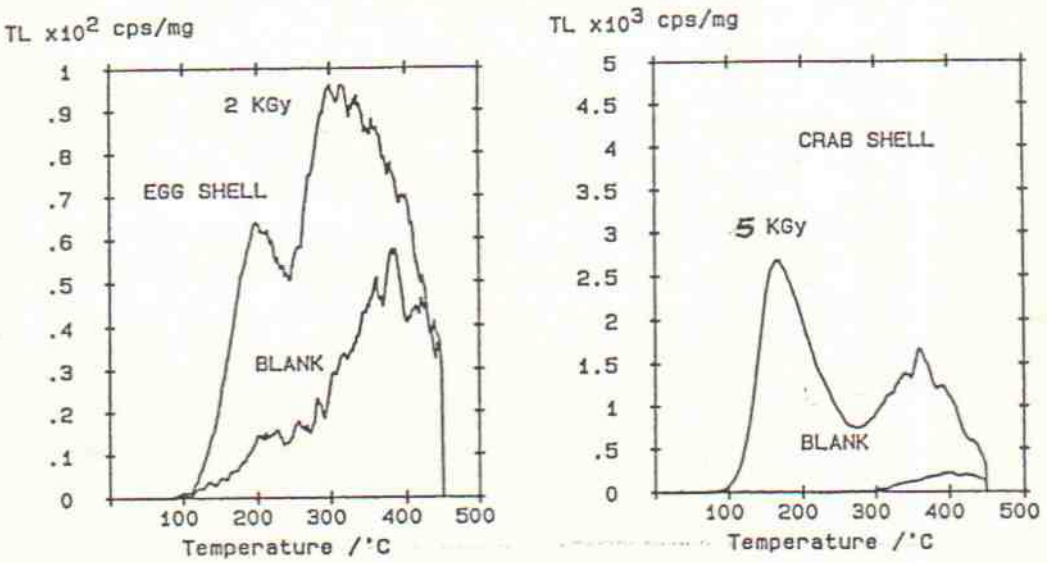
5.4 Extension to other samples.

Preliminary tests were carried out using bio-inorganic samples, ie egg shell and crab shell. Egg shell consists of approximately 3.5 % protein, 1.5 % water and 95 % inorganic matter, mainly calcium carbonate with traces of magnesium carbonate and calcium phosphate (Egan, Kirk & Sawyer, 1981). The main structural component of the carapace of crabs is chitin, a polysaccharide, but this is made hard by the infiltration of calcium salts (Buchsbaum,1974). The presence of inorganic salts in these structures suggests that they might show TL properties.

The egg sell was irradiated to 2 kGy and the crab shell to 5 kGy. Both egg shell and crab shell were broken into small pieces by hand. The crab shell was crushed further using a pestle and mortar without grinding. The irradiated samples and blanks were then dispensed onto stainless steel discs using silicone grease as a contact lubricant. The discs were glowed from ambient temperature to 450°C at 6°C per second. Fig 5.7 shows typical glow curves from these samples. The egg shell was glowed one week after irradiation, having been stored in a refrigerator in the intervening period without being protected from light. The crab shell was glowed two days after irradiation, having been stored in the refrigerator in a black polythene bag.

Both crab shell and egg shell show TL properties. The exoskeletons of other crustaceans have a similar composition, so that thermoluminescence could be used as a method of detecting irradiated lobster and prawns.

5.7 Glow curves from egg shell and crab shell.



6. Towards Photostimulation.

The components for the PTTL/PSL spectrometer described in Report 1 section 5.1 were delivered in April as expected (Report 1, section 5.1). Preliminary characterisation of the 300W Cermax lamp confirmed the beam uniformity and high brightness expected. A series of studies using photodiode detectors have also determined the lamp warm-up characteristics, linearity of power setting response and the expected dependence of power on monochromator slit width. A pyroelectric radiometer and lock-in amplifier was borrowed for a short period to make absolute power density measurements of the lamp output, monochromator efficiency and power loss in the beam producing optics. A power level of roughly 800 microwatts/ sq cm. can be obtained at 50% power throughout the near UV and visible spectrum in a 10nm bandwidth suitable for illuminating 1 cm diameter discs. If necessary it may be possible to modify the beam optics by reducing the focal length of the objective quartz lens to increase the power by a factor of five.

A first generation sample chamber and temperature controller was built in house during the summer to provide a development bed for the ancillary components of the system. This is not yet evacuable, although steps are being taken to machine a vacuum chamber to allow operation at cryogenic temperatures in the near future. The photon counting photomultiplier has been successfully commissioned, although there are still minor shortfalls in the performance of the Ortec multichannel scaling system which are being resolved with the distributer. We are presently awaiting the delivery of a holder for the electro-optic shutter and filters for the photomultiplier, which should complete the system for steady state, and low power pulsed, photostimulated luminescence measurements, and phototransfer measurements. Specification of a laser for high sensitivity pulsed work is not yet possible with total confidence. The intention is to explore the spectral transfer and photosensitivity of selected samples using the low power spectrometer facilities and the first generation sample chamber. When the vacuum chamber for cryogenic work is substituted the original chamber can then be used in Glasgow to finalise the power level specification using an excimer laser capable of generating up to 1J per pulse. Although this side of the project has not yet reached the stage of practical fruition, there has been steady progress since the last report, and it is expected that by concentrating effort in this area it will be possible to make rapid advances now that most components are here and tested.

Meanwhile a preliminary study of the bleaching of the TL signal by monochromatic light from the Xe lamp and early phototransfer experiments using pure microcline feldspar samples has been undertaken. The main objective was to explore the optical sensitivity of a well characterised sample which can in principle act as a model for the minerals removed from food samples.

6.1 Monochromatic bleaching.

Sample discs of pure, fine grain microcline feldspar were prepared by crushing a monogenetic Hebridean polycrystalline microcline and separating the 2-10 micron grain fraction by sedimentation in acetone. This material was preirradiated in a Cobalt-60 source, then resuspended in acetone and dispensed volumetrically onto a series of cleaned stainless steel discs in flat bottomed tubes. After drying in an oven overnight a uniform coating of ~3mg/sq cm resulted. Immediate TL glow curves were recorded and used to select a set of some 30 discs of uniform sensitivity.

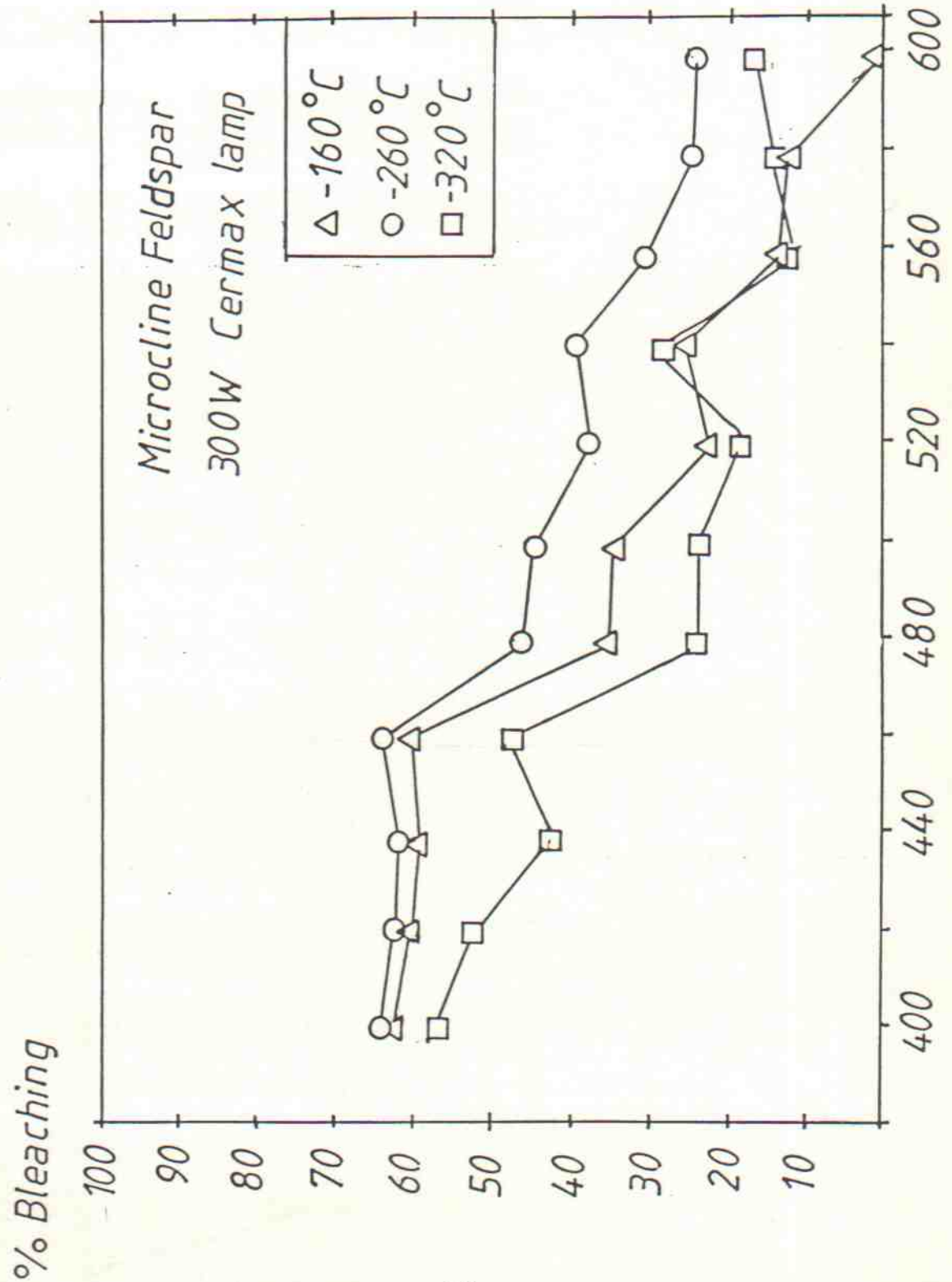
The discs were then irradiated to 10 Gy in the laboratory Sr-90 source. Each disc was irradiated and glowed three times, and in each case reading the TL out exactly 30 minutes after irradiation, heating from ambient temperature to 500°C at 3°C per second. The first glow and third glow recorded TL of the disc without any bleaching, storing the samples in the dark for the 30 minute waiting period. Between irradiation and the second glow each disc was exposed to monochromatic light from the Xe lamp for 15 minutes, using wavelengths from 400-600 nm at 20 nm intervals, with a bandpass of 10 nm. Separate discs were used for each wavelength, checks were made that the illumination did not alter the sample temperature above ambient temperature. The amount of bleaching of the TL signal was calculated as a per cent of the mean unbleached signal, from glows 1 and 3, thus eliminating any influence of glow or dose dependent sensitivity changes.

The data have been analysed to reveal the full relationship between optical sensitivity, bleaching wavelength and thermoluminescence glow temperature. The results for three temperatures are shown in fig. 6.1, indicating the broad spectral susceptibility to bleaching throughout the visible waveband. Up to 60% of the glow curve at 260°C (the region of greatest interest to this study at the moment), can be removed using light from 480-560 nm. The bleaching of the low temperature component (200-300°C) relative to the high temperature component (300-400°C) is also wavelength dependent. Fig. 6.2 suggests that wavelengths of 560nm or 600nm are selective of the glow curve region of greatest interest. At shorter wavelengths the low temperature component is bleached less than at longer wavelengths. Fig. 6.3 shows typical glow curves at 460 nm and 540 nm, indicating the effect on the glow curve.

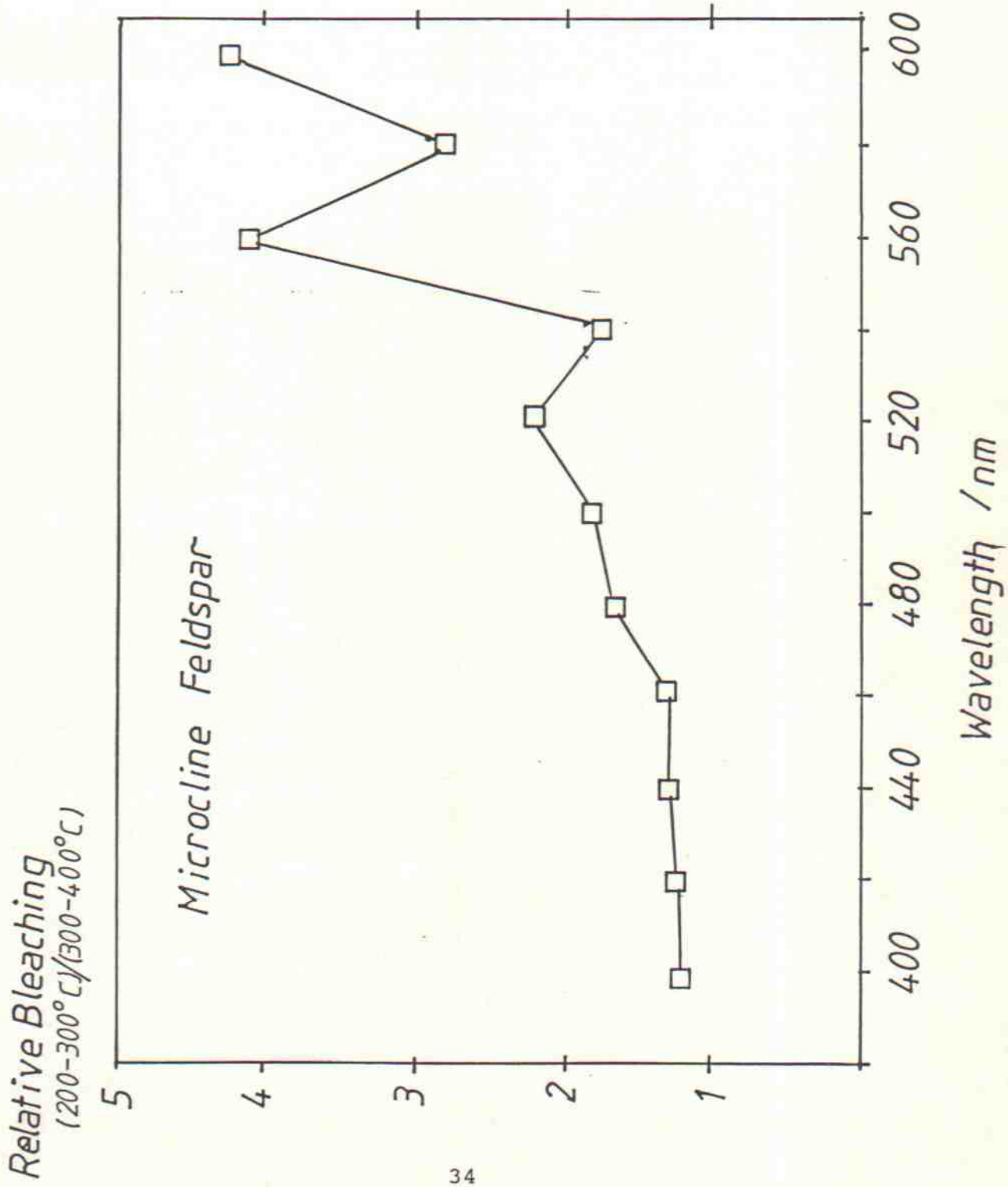
6.2 Room temperature phototransfer.

The experiment was continued to attempt to observe ambient temperature phototransferred TL from the same samples. In this case the discs were thermally washed in the TL reader at 150°C for 15 seconds and then cooled to room temperature between irradiation and illumination to remove the lowest temperature TL peak. They were then exposed to light from the Xe lamp at wavelengths ranging from 400-580 nm at 10 nm intervals (bandpass = 5 nm) for 15 minutes. The discs were glowed on the TL reader 30 minutes after irradiation.

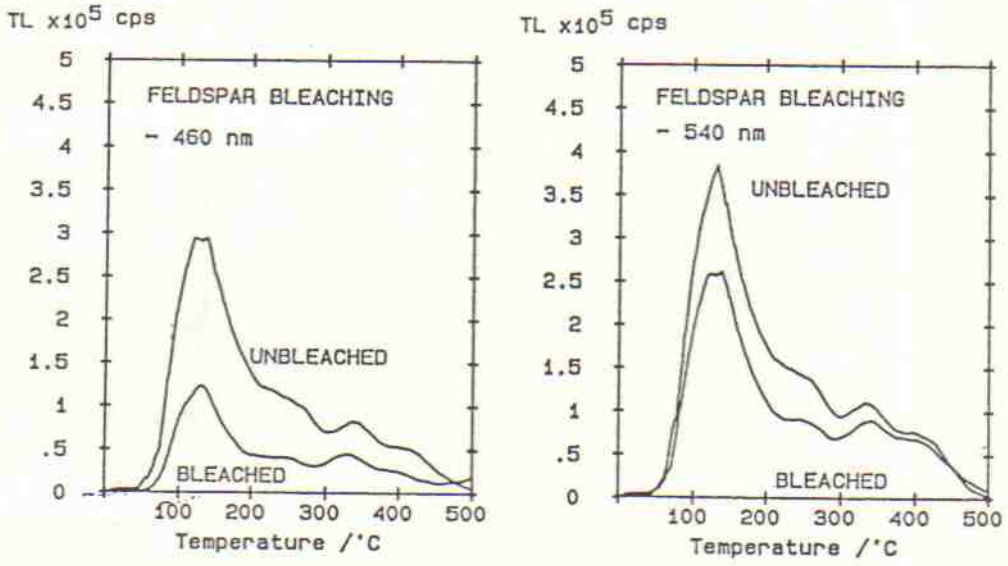
6.1 Bleaching spectrum from microcline feldspar.



6.2 Relative bleaching spectrum.



6.3 Glow curves from microcline feldspar (10 Gy) bleached at 460 nm and 540 nm.



As expected, charge carriers from high temperature traps were transferred to low temperature traps in the region of the curve that had been thermally washed, resulting in a peak at 120°C. The much larger higher temperature TL peak interfered with the upper edge of the phototransferred TL, but this was deconvoluted using a spectral subtraction procedure .

Fig. 6.4 shows the phototransferred peaks at various wavelengths from discs exposed to a 10 Gy beta dose showing the highly reproducible peak shape for this component. The thermal lifetime of this peak is estimated to of the order of one hour at ambient temperature.

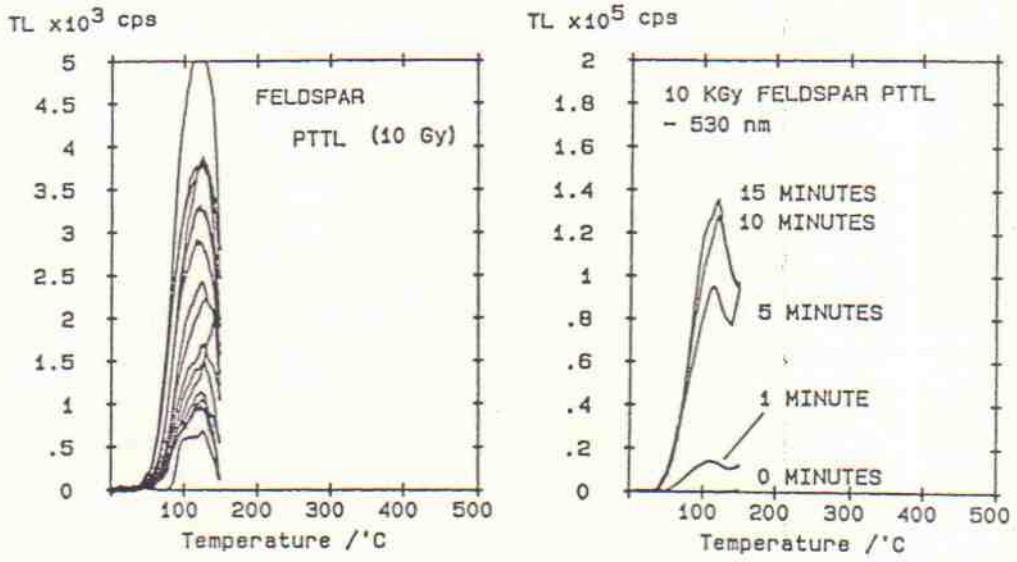
The PTTL efficiency of the 10 Gy discs was calculated by dividing the area of the phototransferred peak by the difference between the area of the bleached and unbleached curves, and expressing this as a per cent. These results are shown in fig. 6.5. Between 1 and 3 % of the lost TL signal was phototransferred. Because of the possibility that the TL efficiency is greater at low than high temperatures these values must be regarded as upper limits to the PTTL capture efficiency. Nevertheless this analysis leads to intriguing questions as to the fate of the 97% or more of the lost charge carriers which are not re-trapped at the PTTL site. They cannot obviously be retrapped at shallower sites at ambient temperature, so the only remaining possibilities are re-trapping at deeper levels from which they are will not re-emerge or relaxation. Part of the relaxation process may well involve luminescent transitions which we hope to record very shortly.

Despite the low PTTL efficiency there is still the possibility of utilising this process as a detection system in its own right. To explore this a second experiment was conducted with 10 kGy irradiated coarse feldspar grains, thermally washed to 200°C and exposed to light at 530 nm for various times ranging from 0-15 minutes. The curves were normalised by fitting the rising edge of the 200°C peak to that of unbleached controls. This shows clearly that the peak production is progressive with illumination time, and that the peak strength at high dose is still readily detectable.

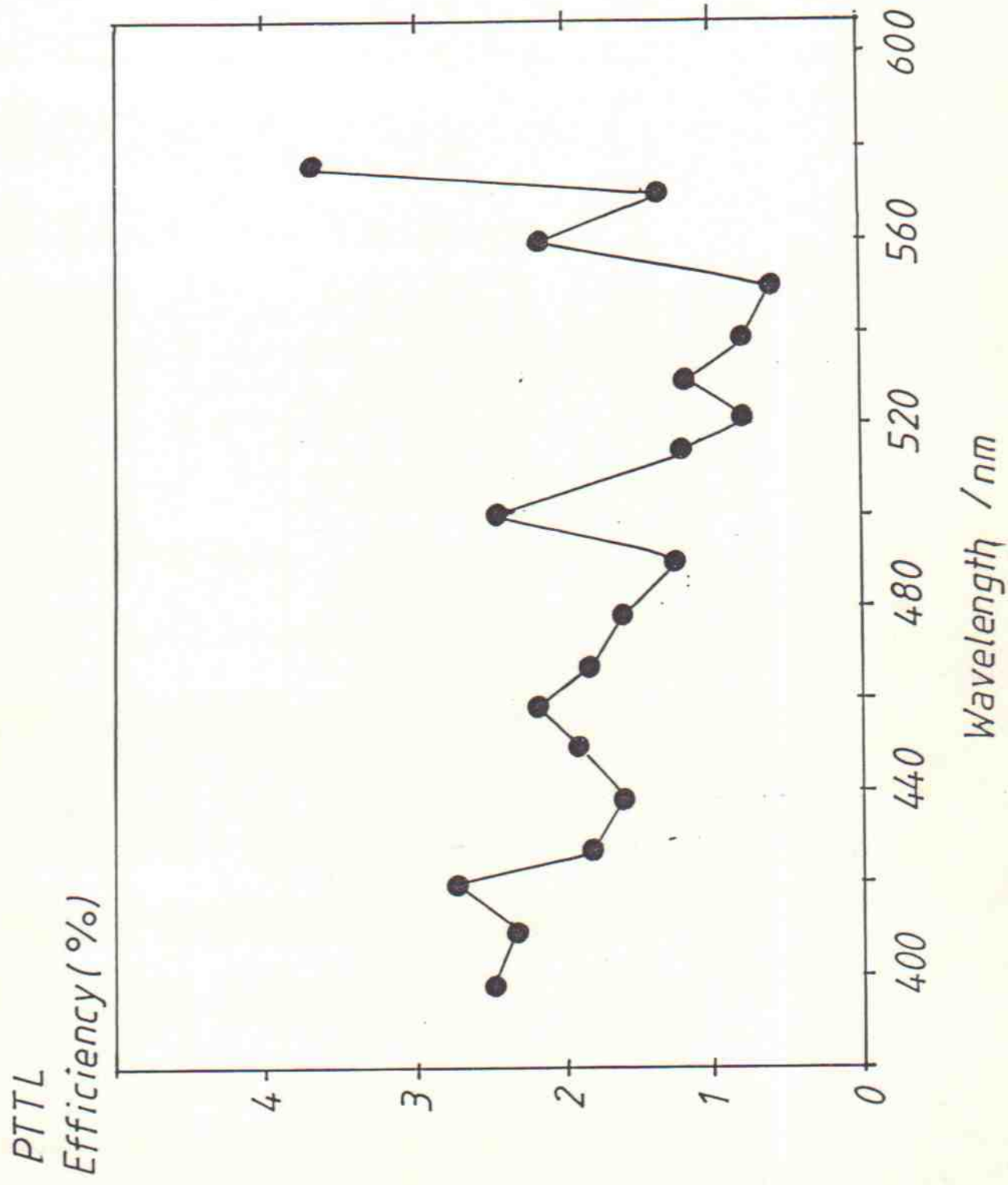
6.3 Future view on photostimulation.

A high priority is planned for investigating both photostimulation possibilities in the next phases of the project. The experiments described above have confirmed our original hypotheses that optical eviction techniques would potentially provide a means of reading out trapped charge without high temperature heating. There are two main avenues of enquiry from here. One involves development of photo-transfer where it seems that even ambient temperature readings are of interest. The use of cooled samples may increase efficiency by providing more abundant receptor centres with high capture cross sections, and also by sharpening up the absorption spectra for optical stimulation. As the spectrometer evolves these possibilities will be investigated.

6.4 Glow curves from PTTL of microcline feldspar (10 Gy dose/15 minutes exposure) at various wavelengths and 10 kGy dose/530 nm after various exposure times.



6.5 PTTL efficiency.



The second approach is to attempt to find out the fate of the missing 97% of charge carriers. Can the luminescence recombination paths be monitored with high efficiency either during steady state illumination, or in pulsed mode?

The use of blocking filters to isolate detection windows from excitation wavelengths is essential for steady state measurements. Initial attempts to achieve this to photon sensitivities were not successful due to cross talk with the lamp. However a new set of filters is being procured for this purpose.

Pulsed measurements have the advantage that detection and stimulation wavelengths do not necessarily need to be isolated, providing that the photomultiplier is not damaged by the stimulation pulse. Furthermore it may be possible by examining the recombination dynamics to isolate different signal components characterising electronic, ionic and molecular processes. Again two experiments are planned. In the first instance an electro-optical shutter will be used to pulse the Xe lamp for spectroscopic investigation of the sensitivity of highly irradiated samples. Thereafter it is intended to use the shutter to protect the PM tube from more intense laser pulses for high efficiency stimulation. The specification of laser type and power would be most prudently deferred until the first pulsed Xe lamp experiments have been completed.

7. Conclusions.

We believe that we now have a qualitative test for the irradiation of herbs, spices, seasoning mixes and vegetables. The whole sample method gives unambiguous results for samples containing salt, and this will be applicable for many years after irradiation. Density separation of the mineral grains from herbs, spices and vegetables can give unambiguous results provided the correct precautions are taken and sufficient grains are recovered. Some samples still present problems of detectability (eg nutmeg, white pepper and dried onions), but the method is applicable to the vast majority of herbs and spices and photostimulated methods may provide the answer for these difficult samples.

The preliminary investigations of optical activity of irradiated feldspar are encouraging and it is hoped that further development will result in rapid and reliable methods which do not require heating or sample separation.

8. Bibliography.

Buchsbaum,R., 1974, Animals without Backbones: vol 2, Penguin, Middlesex, England.

Egan,H., Kirk,R.S., Sawyer,R., 1981, Pearson's Chemical Analysis of Foods, 8th edition, Churchill Livingstone, Edinburgh.

Heide,L. and Bogl,K.W., 1988, Identification of irradiated spices and condiments with luminescence measurements: a European intercomparison, presented at the XIXth Annual Meeting of the European Society of Nuclear Methods in Agriculture, 29 Aug - 2 Sept 1988, Vienna.

Sanderson,D.C.W. and Slater,C., 1988a, Development of luminescence tests to identify irradiated foods: Progress Report 1, SURRC report to MAFF N384, March 1988.

Sanderson,D.C.W. and Slater,C., 1988b, Thermoluminescence measurements of samples from the second ISH Ringversuch, SURRC report to ISH Neuherberg, April 1988.

Sanderson, D.C.W., 1988, Fading of Thermoluminescence of Feldspars: Characteristics and Corrections, Nuclear Tracks, 14, 155-161

9. Appendices.

The appendices provide an update of the laboratory archive. Samples which were detailed in Report 1 are not included here. Please refer to Appendix C of Report 1 for descriptions of the herbs and spices.

SAMPLE LIST

Reference SP54	TL1 from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG. Identity unknown.
Reference SP55	TL2 from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG. Identity unknown.
Reference SP56	TL3 from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG. Identity unknown.
Reference SP57	TL4 from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG. Identity unknown.

RUN SHEET

RUN NUMBER(S): 658-694 Mineral Phase DATE(S): 8.7.88

Disc numbers 29-96 were reirradiated for 1 hour on 6.7.88 & 7.7.88, and glowed on 8.7.88.

(b)Results

Summary file name = BATCH17.2

Filename	Disc no.	Mass of disc (g)	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP111.T3.659.2	29	0.17061	2.5	0.01n	2.39 E 7
SP111.T3.660.2	30	0.17008	2.5	0.01n	1.96 E 6
SP145.T3.661.2	31	0.17006	2.5	0.01n	1.55 E 7
SP145.T3.662.2	32	0.16978	2.5	0.01n	6.28 E 5
SP148.T3.663.2	33	0.17356	2.5	0.01n	1.81 E 6
SP148.T3.664.2	34	0.17210	2.5	0.01n	5.70 E 6
SP191.T3.665.2	35	0.16999	2.5	0.01n	4.66 E 6
SP191.T3.666.2	36	0.17251	2.5	0.01n	3.01 E 6
SP174.T3.667.2	37	0.16890	2.5	0.01n	1.74 E 6
SP174.T3.668.2	38	0.17067	2.5	0.01n	3.19 E 5
SP176.T3.669.2	39	0.17051	2.5	0.01n	3.94 E 6
SP176.T3.670.2	40	0.17093	2.5	0.01n	7.97 E 6
SP11 T3.671.2	41	0.17267	2.5	0.01n	4.94 E 5
SP11.T3.672.2	42	0.16844	2.5	0.01n	1.12 E 6
*SP110.T3.673.2	43	0.17024	2.5	0.01n	8.83 E 5
+SP110.T3.674.2	44	0.17459	2.5	0.01n	1.16 E 6
SP157.T3.675.2	45	0.17338	2.5	0.01n	7.82 E 6
SP157.T3.676.2	46	0.17006	2.5	0.01n	1.39 E 7
SP131.T3.677.2	47	0.17385	2.5	0.01n	2.22 E 5
SP131.T3.678.2	48	0.17162	2.5	0.01n	6.08 E 5
SP13 T3.679.2	49	0.17189	2.5	0.01n	1.74 E 5
SP13.T3.680.2	50	0.17214	2.5	0.01n	1.24 E 5
SP122.T3.681.2	51	0.17071	2.5	0.01n	9.29 E 6
SP122.T3.682.2	52	0.17097	2.5	0.01n	1.20 E 7
SP26 T3.683.2	53	0.17026	2.5	0.01n	7.20 E 5
SP26.T3.684.2	54	0.17080	2.5	0.01n	3.26 E 5
SP167.T3.685.2	55	0.17192	2.5	0.01n	2.13 E 6
SP167.T3.686.2	56	0.17020	2.5	0.01n	3.41 E 6
SP114.T3.687.2	57	0.17002	2.5	0.01n	2.80 E 5
SP114.T3.688.2	58	0.17274	2.5	0.01n	3.48 E 5
SP214.T3.689.2	59	0.17194	2.5	0.01n	1.76 E 7
SP214.T3.690.2	60	0.17256	2.5	0.01n	2.28 E 7
SP18 T3.691.2	61	0.17081	2.5	0.01n	3.88 E 4
SP18.T3.692.2	62	0.17092	2.5	0.01n	6.51 E 4
SP19 T3.693.2	63	0.17151	2.5	0.01n	2.76 E 5
SP19.T3.694.2	64	0.17231	2.5	0.01n	5.50 E 5

n = nominal weight
* = cake of sample had fallen off before 2nd glow.
+ = cake of sample blew off during 2nd glow.

RUN SHEET

RUN NUMBER(S): 695-726 Mineral Phase DATE(S): 8.7.88

Disc numbers 29-96 were reirradiated for 1 hour on 6.7.88 & 7.7.88, and glowed on 8.7.88.

(b)Results

Summary file name = BATCH17.2

Filename	Disc no.	Mass of disc (g)	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP216.T3.695.2	65	0.16940	2.5	0.01n	1.35 E 7
SP216.T3.696.2	66	0.17087	0	0.01n	1.51 E 7
SP30 T3.697.2	67	0.16980	2.5	0.01n	6.90 E 5
SP30.T3.698.2	68	0.17010	0	0.01n	5.25 E 5
SP34B.T3.699.2	69	0.17178	2.5	0.01n	1.25 E 5
SP34B.T3.700.2	70	0.17057	0	0.01n	4.44 E 6
SP24 T3.701.2	71	0.17169	2.5	0.01n	4.94 E 6
SP24.T3.702.2	72	0.16993	0	0.01n	7.66 E 6
SP136.T3.703.2	73	0.16892	2.5	0.01n	1.18 E 6
SP136.T3.704.2	74	0.17120	0	0.01n	1.57 E 6
SP159.T3.705.2	75	0.17068	2.5	0.01n	4.09 E 6
SP159.T3.706.2	76	0.16893	0	0.01n	2.95 E 6
SP220.T3.707.2	77	0.17133	2.5	0.01n	1.10 E 8
SP220.T3.708.2	78	0.17070	0	0.01n	2.45 E 8
SP165.T3.709.2	79	0.17033	2.5	0.01n	1.50 E 6
SP165.T3.710.2	80	0.17186	0	0.01n	7.96 E 5
SP217.T3.711.2	81	0.17299	2.5	0.01n	9.29 E 4
SP217.T3.712.2	82	0.17014	0	0.01n	1.85 E 6
SP215.T3.713.2	83	0.17003	2.5	0.01n	2.87 E 6
SP215.T3.714.2	84	0.16970	0	0.01n	2.92 E 6
SP198.T3.715.2	85	0.17086	2.5	0.01n	1.45 E 7
SP198.T3.716.2	86	0.17292	0	0.01n	2.72 E 7
SP140.T3.717.2	87	0.17009	2.5	0.01n	2.71 E 6
SP140.T3.718.2	88	0.17060	0	0.01n	8.82 E 6
SP203.T3.719.2	89	0.16888	2.5	0.01n	1.31 E 7
SP203.T3.720.2	90	0.17163	0	0.01n	6.94 E 7
SP29.T3.721.2	91	0.16826	2.5	0.01n	3.08 E 5
SP29.T3.722.2	92	0.17004	0	0.01n	3.15 E 6
SP161.T3.723.2	83	0.17083	2.5	0.01n	2.37 E 5
SP161.T3.724.2	94	0.17086	0	0.01n	3.56 E 7
SP137.T3.725.2	95	0.16942	2.5	0.01n	7.01 E 6
SP137.T3.726.2	96	0.17104	0	0.01n	4.29 E 6

n = nominal weight

RUN SHEET

RUN NUMBER(S): 887-937 DATE(S): Separated: 20.10.88

Density separation of Batch 20 Blank herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. A reagent blank was included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them in a plastic cap and wrapping them individually using "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): 887-937 DATE(S): Separated: 20.10.88
Glowed: 21.10.88 1st
24.10.88 2nd

Density separation of Batch 20 Blank herbs and spices by CS.

Summary file name: BATCH20 BLANKS

Filename	TL 250-260'C 1st Glow	TL 250-260'C 2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP109.T3.887.	500	19255	2.60 E-2	2.30 E-2
SP111.T3.889.	78780	8422860	9.35 E-3	8.27 E-3
SP112.T3.891.	Disc upside down , therefore repeat			
SP113.T3.893.	20	11665	1.71 E-3	1.51 E-3
$SP115.T3.895.	130	2215	5.87 E-2	5.19 E-2
$SP116.T3.897.	4320	91430	4.72 E-2	4.17 E-2
$SP117.T3.899.	10	46660	2.14 E-4	1.89 E-4
SP118.T3.901.	8190	385320	2.12 E-2	1.87 E-2
SP119.T3.903.	535	101535	5.27 E-3	4.66 E-3
SP120.T3.905.	10845	1653290	6.56 E-3	5.80 E-3
SP121.T3.907.	535	117405	4.56 E-3	4.03 E-3
SP123.T3.909.	120	6100	1.97 E-2	1.74 E-2
SP124.T3.911.	765	351885	2.17 E-3	1.92 E-3
$SP125.T3.913.	25	128365	1.95 E-4	1.72 E-4
$SP126.T3.915.	15	81110	1.85 E-4	1.64 E-4
SP127.T3.917.	130	242705	5.36 E-4	4.74 E-4
SP128.T3.919.	95675	4349950	2.20 E-2	1.94 E-2
$SP129.T3.921.	41785	1097935	3.81 E-2	3.37 E-2
SP130.T3.923.	13740	1549450	8.89 E-3	7.84 E-3
SP132.T3.925.	695	154480	4.50 E-3	3.98 E-3
SP133.T3.927.	10	3020	3.31 E-3	2.93 E-3
SP135.T3.929.	1540	772770	1.99 E-3	1.76 E-3
SP138.T3.931.	235	246430	9.54 E-4	8.43 E-4
SP139.T3.933.	365	174630	2.09 E-3	1.85 E-3
$SP141.T3.935.	10	214600	4.66 E-5	4.11 E-5
*RB20.B1.937.	10	7695	1.30 E-3	1.15 E-3
BLANK DISC1.	10	3075	3.25 E-3	2.87 E-3
BLANK DISC2.	10	1165	8.58 E-3	7.58 E-3

Nominal weight 0.1mg entered for all samples.
Less than 10 counts recorded as 10.

*RB=Reagent blank,Batch20.Blank.Run no.
$ Sample reseparated in Batch 24.

+ New Ratio= dose normalised ratio

$$= \text{Ratio Glow1:Glow2} * \frac{\text{Measured dose}}{2.5}$$

$$= \text{Ratio Glow1:Glow2} * 0.884$$

RUN SHEET

RUN NUMBER(S): 888-942 DATE(S): Separated: 21.10.88

Density separation of Batch 20 10kGy herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. Several reagent blank were included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them in a plastic cap and wrapping them individually using "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): 888-942 DATE(S): Separated: 21.10.88
Glowed: 24.10.88 1st
25.10.88 2nd

Density separation of Batch 20 10kGy herbs and spices by CS.

Summary file name: BATCH20 IRRADIATED

Filename	TL 250-260'C 1st Glow	2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP109.T3.888.	368815	145050	2.54	2.51
SP111.T3.890.	8284515	2917730	2.84	2.81
SP112.T3.892.	3261835	1427100	2.29	2.26
SP113.T3.894.	Disc upside down, therefore repeat			
SP115.T3.896.	1063965	928975	1.14	1.13
SP116.T3.898.	1083495	527995	2.05	2.02
SP117.T3.900.	206440	133135	1.55	1.53
SP118.T3.902.	2612420	1143760	2.28	2.25
SP119.T3.904.	412120	148850	2.77	2.74
SP120.T3.906.	21996510	9245445	2.38	2.35
SP121.T3.908.	Sample dislodged, therfore repeat			
SP123.T3.910.	37540	6115	5.67	5.60
SP124.T3.912.	1957490	683815	2.86	2.83
SP125.T3.914.	407865	175350	2.33	2.30
SP126.T3.916.	128525	30140	4.26	4.21
SP127.T3.918.	467830	218860	2.14	2.11
SP128.T3.920.	24685515	10346040	2.39	2.36
SP129.T3.922.	24149675	6577015	3.67	3.63
SP130.T3.924.	16550690	7931295	2.09	2.06
SP132.T3.926.	5513610	2219600	2.48	2.45
SP133.T3.928.	35910	22015	1.63	1.63
SP135.T3.930.	Centrifuge tube broke , sample lost			
SP138.T3.932.	476790	200975	2.37	2.34
SP139.T3.934.	497495	139420	3.57	3.53
SP141.T3.936.	221830	133260	1.66	1.64
RB20.I1.938	2925	3080	0.95	0.94
RB20.I2.940	10	950	1.05E-2	1.04E-2
RB20.I3.942	60	11275	5.32E-3	5.26E-3

Nominal weight 0.1mg entered for all samples.

+ New Ratio= dose normalised ratio

$$= \text{Ratio Glow1:Glow2} * \frac{\text{Measured dose}}{2.5} * \frac{10}{\text{Measured dose}}$$

$$= \text{Ratio Glow1:Glow2} * 0.988$$

RUN SHEET

RUN NUMBER(S): 943-999 DATE(S): Separated: 25.10.88

Density separation of Batch 21 Blank herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. Several reagent blanks were included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them on an adhesive strip, covering them with a plastic cap and wrapping them individually with "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): 943-999 DATE(S): Separated: 25.10.88
Glowed: 26.10.88 1st
27.10.88 2nd

Density separation of Batch 21 Blank herbs and spices by CS.

Summary file name: BATCH21 BLANKS

Filename	TL 250-260'C 1st Glow	2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP112.T3.891.	4195	438375	9.57 E-3	8.11 E-3
SP144.T3.943.	110	5170	2.13 E-2	1.81 E-2
SP145.T3.945.	8225	1559145	5.28 E-3	4.48 E-3
SP146.T3.947.	1000	49655	2.01 E-2	1.70 E-2
SP147A.T3.949.	8020	1021770	7.85 E-3	6.66 E-3
SP147B.T3.951.	16650	3287110	5.07 E-3	4.30 E-3
SP149.T3.953.	1430	747330	1.91 E-3	1.01 E-3
SP150.T3.955.	6795	262705	2.59 E-2	2.20 E-2
SP151.T3.957.	55	39175	1.40 E-3	1.19 E-3
$SP152.T3.959.	10	34645	2.89 E-4	2.45 E-4
SP153.T3.961.	79515	7878610	1.01 E-2	8.56 E-3
SP154.T3.963.	13175	3969375	3.32 E-3	2.82 E-3
SP155.T3.965.	5945	610075	9.74 E-3	8.26 E-3
SP156.T3.967.	91155	7637520	9.46 E-3	8.02 E-3
SP158.T3.969.	6315	1486655	4.25 E-3	3.60 E-3
SP160.T3.971.	5850	1959895	2.98 E-3	2.52 E-3
$SP162.T3.973.	105	278185	3.77 E-4	3.20 E-4
SP163.T3.975.	55	106360	5.17 E-4	4.38 E-4
SP164.T3.977.	130	70225	1.85 E-3	1.57 E-3
SP166.T3.979.	295	433865	6.80 E-4	5.77 E-4
SP168.T3.981.	5150	438500	1.17 E-2	9.92 E-3
$SP169.T3.983.	840	13270	6.33 E-2	5.37 E-2
SP170.T3.985.	2255	299875	7.52 E-3	6.38 E-3
SP171.T3.987.	10	10175	9.83 E-4	8.34 E-4
SP172.T3.989.	6345	428380	1.48 E-2	1.26 E-2
$SP173.T3.991.	1930	20510	9.41 E-2	7.98 E-2
RB21.B1.993.	10	6840	1.46 E-3	1.24 E-3
RB21.B2.995.	10	38495	2.60 E-4	2.20 E-4
RB21.B3.997.	8270	361020	2.29 E-2	1.94 E-2
RB21.B4.999.	10	16420	6.09 E-4	5.16 E-4

Nominal weight 0.1mg entered for all samples.

$ Sample reseparated in Batch 24.

+ New Ratio= dose normalised ratio

$$= \text{Ratio Glow1:Glow2} * \frac{\text{Measured dose}}{2.5}$$

$$= \text{Ratio Glow1:Glow2} * 0.848$$

RUN SHEET

RUN NUMBER(S): 944-998 DATE(S): Separated: 26.10.88

Density separation of Batch 21 10kGy herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. Several reagent blanks were included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them on an adhesive strip, covering them with a plastic cap and wrapping them individually with "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): 944-998 DATE(S): Separated: 26.10.88
Glowed: 27.10.88 1st
28.10.88 2nd

Density separation of Batch 21 10kGy herbs and spices by CS.

Summary file name: BATCH21 IRRADIATED

Filename	TL 250-260'C 1st Glow	TL 250-260'C 2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP113.T3.894.	6975	3475	2.01	2.03
SP135.T3.930.	1437005	653580	2.20	2.22
SP144.T3.944.	30545	19045	1.60	1.62
SP145.T3.946.	1712015	678970	2.52	2.54
SP146.T3.948.	1419545	471395	3.01	3.04
SP147A.T3.950.	9456425	3639240	2.60	2.63
SP147B.T3.952.	10307450	4304730	2.39	2.41
SP149.T3.954.	315015	169810	1.86	1.88
SP150.T3.956.	258980	81795	3.17	3.20
SP151.T3.958.	294195	74660	3.94	3.98
SP152.T3.960.	470290	284635	1.65	1.67
SP153.T3.962.	3721605	1480180	2.51	2.53
SP154.T3.964.	2421900	1385230	1.75	1.77
SP155.T3.966.	296395	132905	2.23	2.25
SP156.T3.968.	8258210	3639195	2.27	2.29
SP158.T3.970.	3352205	1470800	2.28	2.30
SP160.T3.972.	3856725	1708310	2.26	2.28
SP162.T3.974.	507565	295075	1.72	1.74
SP163.T3.976.	271460	144620	1.88	1.90
SP164.T3.978.	75390	54130	1.39	1.40
SP166.T3.980.	1622480	1015490	1.60	1.62
SP168.T3.982.	481500	172535	2.79	2.82
SP169.T3.984.	398360	188095	2.12	2.14
SP170.T3.986.	28420	9780	2.91	2.94
SP171.T3.988.	1203395	538200	2.24	2.26
SP172.T3.990.	2248525	765110	2.94	2.97
SP173.T3.992.	83895	40885	2.05	2.07
RB21.B1.994.	3040	22470	1.33 E-1	1.36 E-1
RB21.B2.996.	60	12640	4.75 E-3	4.80 E-3
RB21.B3.998.	80	10715	7.47 E-3	7.54 E-3

Nominal weight 0.1mg entered for all samples.

+ New Ratio= dose normalised ratio

$$= \text{Ratio Glow1:Glow2} * \frac{\text{Measured dose}}{2.5} * \frac{10}{\text{Measured dose}}$$

$$= \text{Ratio Glow1:Glow2} * 1.01$$

RUN SHEET

RUN NUMBER(S): 1001-1059 DATE(S): Separated: 28.10.88

Density separation of Batch 22 Blank herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. Several reagent blanks were included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them on an adhesive strip, covering them with a plastic cap and wrapping them individually with "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): 1001-1059 DATE(S): Separated: 28.10.88
Glowed: 31.10.88 1st
1.11.88 2nd

Density separation of Batch 22 Blank herbs and spices by CS.

Summary file name: BATCH22 BLANKS

Filename	TL 250-260'C 1st Glow	2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP177.T3.1001.	1475	75235	1.96 E-2	1.58 E-2
SP178.T3.1003.	31615	8881605	3.56 E-3	2.88 E-3
SP179.T3.1005.	3255	693645	4.69 E-3	3.79 E-3
SP180.T3.1007.	190	25340	7.50 E-3	6.06 E-3
SP181.T3.1009.	50	3075	1.63 E-2	1.32 E-2
SP185.T3.1011.	12040	1612665	7.47 E-3	6.03 E-3
$SP186.T3.1013.	220	4205	5.23 E-2	4.23 E-2
SP188.T3.1015.	28160	3041880	9.26 E-3	7.48 E-3
SP189.T3.1017.	51525	23671400	2.18 E-3	1.76 E-3
SP190.T3.1019.	1705	1057885	1.61 E-3	1.29 E-3
SP192.T3.1021.	2065	96170	2.15 E-2	1.74 E-2
SP194.T3.1023.	275	27710	9.92 E-3	8.02 E-3
$SP196.T3.1025.	15	47450	3.16 E-4	2.55 E-4
SP197.T3.1027.	720	584970	1.23 E-3	9.94 E-4
SP199.T3.1029.	5755	7281465	7.90 E-4	6.38 E-4
SP200.T3.1031.	4850	2394420	2.03 E-3	1.64 E-3
$SP201.T3.1033.	5	242265	2.06 E-5	1.66 E-5
SP202.T3.1035.	585	1022735	5.72 E-4	4.62 E-4
SP204.T3.1037.	2640	158640	1.66 E-2	1.34 E-2
SP205.T3.1039.	880	230475	3.82 E-3	3.09 E-3
SP206.T3.1041.	9670	889285	1.09 E-2	8.81 E-2
$SP210.T3.1043.	100	361790	2.76 E-4	2.23 E-4
SP211.T3.1045.	100860	3829565	2.63 E-2	2.13 E-2
SP213.T3.1047.	10	7195	1.39 E-3	1.12 E-3
SP218.T3.1049.	2575	1205010	2.14 E-3	1.73 E-3
RB22.B1.1051.	10	3565	2.18 E-3	1.76 E-3
RB22.B2.1053.	50	20510	2.44 E-3	1.97 E-3
RB22.B3.1055.	135	5725	2.36 E-2	1.91 E-2
RB22.B4.1057.	45	4670	9.64 E-3	7.79 E-3
RB22.B5.1059.	225	3445	6.53 E-2	5.27 E-2

Nominal weight 0.1mg entered for all samples.

$ Sample reseparated in Batch 24.

+ New Ratio= dose normalised ratio

$$= \text{Ratio Glow1:Glow2} * \frac{\text{Measured dose}}{2.5}$$

$$= \text{Ratio Glow1:Glow2} * 0.808$$

RUN SHEET

RUN NUMBER(S): 1002-1058 DATE(S): Separated: 31.10.88

Density separation of Batch 22 10kGy herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. Several reagent blanks were included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them on an adhesive strip, covering them with a plastic cap and wrapping them individually with "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): 1002-1058 DATE(S): Separated: 31.10.88
Glowed: 1.11.88 1st
2.11.88 2nd

Density separation of Batch 22 10kGy herbs and spices by CS.

Summary file name: BATCH22 IRRADIATED

Filename	TL 250-260°C 1st Glow	TL 250-260°C 2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP121.T3.908.	499695	220385	2.27	2.29
SP177.T3.1002.	1637775	465015	3.52	3.56
SP178.T3.1004.	28061305	10717435	2.62	2.65
SP179.T3.1006.	2719965	678395	4.01	4.05
SP180.T3.1008.	91920	119740	0.77	0.78
SP181.T3.1010.	55305	31315	1.77	1.79
SP185.T3.1012.	6964010	3507270	1.99	2.01
SP186.T3.1014.	16820	12845	1.31	1.32
SP188.T3.1016.	3899810	863110	4.52	4.57
SP189.T3.1018.	37534890	28710560	1.31	1.32
SP190.T3.1020.	1841875	752035	2.45	2.47
SP192.T3.1022.	364900	160255	2.28	2.30
SP194.T3.1024.	200550	60325	3.32	3.35
SP196.T3.1026.	412450	235245	1.75	1.77
SP197.T3.1028.	11189965	3324175	3.37	3.40
SP199.T3.1030.	19759565	9500045	2.08	2.10
SP200.T3.1032.	10640325	4506585	2.36	2.38
SP201.T3.1034.	17475840	2695025	6.48	6.54
SP202.T3.1036.	1159190	451875	2.56	2.58
SP204.T3.1038.	1395710	499185	2.79	2.82
SP205.T3.1040.	268380	139985	1.92	1.94
SP206.T3.1042.	5110645	2140950	2.39	2.41
SP210.T3.1044.	1680350	495125	3.39	3.42
SP211.T3.1046.	9768675	4720815	2.07	2.09
SP213.T3.1048.	15680	11885	1.32	1.33
SP218.T3.1050.	9520435	2927475	3.25	3.28
RB22.B1.1052.	10	17165	5.83 E-4	5.89 E-4
RB22.B2.1054.	10	2755	3.63 E-3	3.67 E-3
RB22.B3.1056.	10	5445	1.84 E-3	1.86 E-3
RB22.B4.1058.	10	4790	2.09 E-3	2.11 E-3

Nominal weight 0.1mg entered for all samples.

+ New Ratio= dose normalised ratio

$$= \text{Ratio Glow1:Glow2} * \frac{\text{Measured dose}}{2.5} * \frac{10}{\text{Measured dose}}$$

$$= \text{Ratio Glow1:Glow2} * 1.01$$

RUN SHEET

RUN NUMBER(S): 1061-1119 DATE(S): Separated: 2.11.88

Density separation of Batch 23 Blank herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. Several reagent blanks were included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them on an adhesive strip, covering them with a plastic cap and wrapping them individually with "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): 1061-1119 DATE(S): Separated: 2.11.88
Glowed: 3.11.88 1st
4.10.88 2nd

Density separation of Batch 23 Blank herbs and spices by CS.

Summary file name: BATCH23 BLANKS

Filename	TL 250-260'C 1st Glow	TL 250-260'C 2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP5.T3.1061.	10	40600	2.46 E-4	1.99 E-4
SP6.T3.1063.	465	30035	1.55 E-2	1.25 E-2
$SP7.T3.1065.	2970	9100	3.26 E-1	2.63 E-1
SP8.T3.1067.	21880	1637990	1.34 E-2	1.08 E-2
$SP9.T3.1069.	630	4935	1.28 E-1	1.03 E-1
SP10.T3.1071.	10	11860	8.43 E-4	6.81 E-4
$SP12.T3.1073.	25	71850	3.48 E-4	2.81 E-4
$SP14.T3.1075.	820	18350	4.47 E-2	3.61 E-2
SP15.T3.1077.	20265	12134075	1.63 E-3	1.35 E-3
SP17.T3.1079.	785	120770	6.50 E-3	5.25 E-3
$SP20.T3.1081.	8530	113150	6.41 E-2	5.18 E-2
SP22.T3.1083.	17715	2493335	7.10 E-3	5.74 E-3
SP23.T3.1085.	1880	567495	3.31 E-3	2.67 E-3
SP25.T3.1087.	145	32580	4.45 E-3	3.60 E-3
SP27.T3.1089.	2515	1272280	1.98 E-3	1.60 E-3
SP28.T3.1091.	4865	1961450	2.48 E-3	2.00 E-3
$SP31.T3.1093.	10	90025	1.11 E-4	8.97 E-5
SP32.T3.1095.	85	122815	6.92 E-4	5.59 E-4
SP33.T3.1097.	165	27160	6.07 E-3	4.90 E-3
SP34A.T3.1099.	4195	657165	6.38 E-3	5.16 E-3
SP35.T3.1101.	1165	174045	6.69 E-3	5.40 E-3
SP36.T3.1103.	8350	3009410	2.77 E-3	2.24 E-3
SP37.T3.1105.	15	2915	5.15 E-3	4.16 E-3
SP41.T3.1107.	715	4710	1.52 E-1	1.23 E-1
SP108.T3.1109.	55090	4735185	1.16 E-2	9.37 E-3
RB23.B1.1111.	2780	20150	1.38 E-1	1.12 E-1
RB23.B2.1113.	325	8090	4.02 E-2	3.25 E-2
RB23.B3.1115.	105	7775	1.35 E-2	1.09 E-2
RB23.B4.1117.	195	7165	2.72 E-2	2.20 E-2
RB23.B5.1119.	50	8055	6.21 E-3	5.02 E-3

Nominal weight 0.1mg entered for all samples.

$ Sample reseparated in Batch 24.

+ New Ratio= dose normalised ratio

$$= \text{Ratio Glow1:Glow2} * \frac{\text{Measured dose}}{2.5}$$

$$= \text{Ratio Glow1:Glow2} * 0.808$$

RUN SHEET

RUN NUMBER(S): 1062-1120 DATE(S): Separated: 3.11.88

Density separation of Batch 23 10kGy herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. Several reagent blanks were included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them on an adhesive strip, covering them with a plastic cap and wrapping them individually with "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): 1062-1120 DATE(S): Separated: 3.11.88
Glowed: 4.11.88 1st
7.10.88 2nd

Density separation of Batch 23 10kGy herbs and spices by CS.

Summary file name: BATCH23 IRRADIATED

Filename	TL 250-260'C 1st Glow	2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP5.T3.1062.	43825	15565	2.82	3.01
SP6.T3.1064.	61245	35965	1.70	1.81
SP7.T3.1066.	66570	30720	2.17	2.31
SP8.T3.1068.	2195060	673025	3.26	3.38
SP9.T3.1070.	117045	42650	2.74	2.92
SP10.T3.1072.	200	8970*	2.23 E-2	2.38 E-2
SP12.T3.1074.	356300	106605	3.34	3.56
SP14.T3.1076.	4030	3660	1.10	1.17
SP15.T3.1078.	12000275	7351150	1.63	1.74
SP17.T3.1080.	5408535	1635240	3.31	3.53
SP20.T3.1082.	619095	138680	4.46	4.75
SP22.T3.1084.	153090	38380	3.99	4.25
SP23.T3.1086.	52115	25950	2.01	2.14
SP25.T3.1088.	22000	33360	0.66	0.70
SP27.T3.1090.	3638345	925885	3.93	4.19
SP28.T3.1092.	762245	371500	2.05	2.19
SP31.T3.1094.	71040	41485	1.71	1.82
SP32.T3.1096.	20650	20525	1.01	1.08
SP33.T3.1098.	10785	13300	0.81	0.86
SP34A.T3.1100.	385340	204325	1.59	1.69
SP35.T3.1102.	255510	146205	1.75	1.86
SP36.T3.1104.	339675	152075	2.23	2.38
SP37.T3.1106.	108000	77210	1.40	1.49
SP41.T3.1108.	1975	25495*	7.75 E-2	8.26 E-2
SP108.T3.1110.	10449070	3825070	2.73	2.91
RB23.I1.1112.	105	8265	1.27 E-2	1.35 E-2
RB23.I2.1114.	245	23140	1.06 E-2	1.13 E-2
RB23.I3.1116.	385	7740	4.97 E-2	5.30 E-2
RB23.I4.1118.	20	4670	4.28 E-3	4.56 E-3
RB23.I5.1120.	70	6345	1.10 E-2	1.17 E-2

Nominal weight 0.1mg entered for all samples.

+ New Ratio= dose normalised ratio

$$= \text{Ratio Glow1:Glow2} * \frac{\text{Measured dose}}{2.5} * \frac{10}{\text{Measured dose}}$$

$$= \text{Ratio Glow1:Glow2} * 1.066$$

* Cross-contamination from neighbouring high sensitivity sample a possibility.

RUN SHEET

RUN NUMBER(S): Various DATE(S): Separated: 9.11.88

Density separation of Batch 24 Blank herbs and spices by CS.

This batch was composed of samples which appeared at the extreme ends of the histogram of renormalised data. Extra care was taken to control cross-contamination. All glassware was cleaned with acetone immediately prior to use and covered with "cling-film" to prevent contamination from the air.

(a)Procedure

(i) The sample was placed in a large, clean centrifuge tube to a depth of 0.5cm.
(ii) Sodium polytungstate (1.70 g/cc) was added to half fill the tube. The sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s.
(iv) The upper layer was decanted through a filter into a large beaker. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for reconcentration after triple filtration.
(v) The mineral fraction was washed with deionised water, transferred to a small centrifuge tube,covered in cling film and allowed to stand until required. The large centrifuge tubes were washed thoroughly and reused. Several reagent blanks were included.
(vi) The aqueous phase was poured through the same filter as before. The diluted density fluid was retained for reconcentration. The mineral phase was washed once more and allowed to stand for 5 minutes.
(vii) The mineral phase was washed in 1M.HCl to a depth of 1cm for 15 minutes. The acid was neutralised by the addition of ammonia , diluted to half fill the tube and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and allowed to stand for 5 minutes, twice.
(viii)The mineral phase was washed in acetone and allowed to stand for 5 minutes.
(ix) A clean stainless steel disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone was transfered to the settling tubes. The tubes were placed in an oven at 55'C overnight to dry.
(x) The discs were read on the TL reader , heating to 450'C at 6'C per minute.
(xi) The discs were packaged for reirradiation by placing them on an adhesive strip, covering them with a plastic cap and wrapping them individually with "cling film". The caps were placed in petrie dishes to stop them moving about.
(xii) The discs were reirradiated to a 2.5kGy dose and glowed again after a preheat at 50'C for one hour. The data was renormalised to the second glow.

RUN SHEET

RUN NUMBER(S): Various DATE(S): Separated: 8.11.88
Glowed: 9.11.88 1st
10.11.88 2nd

Density separation of Batch 24 Blank herbs and spices by CS.

Summary file name: BATCH24 BLANKS

Filename	TL 250-260'C 1st Glow	2nd Glow	Ratio of Glow 1:Glow 2	New Ratio+
SP7.T3.1065.3&4	2870	116200	2.47 E-2	2.21 E-2
SP9.T3.1069.3&4	590	1130	5.22 E-1	4.68 E-1
SP12.T3.1073.3&4	1105	171805	6.43 E-3	5.76 E-3
SP14.T3.1075.3&4	215	785	2.74 E-1	2.46 E-1
SP20.T3.1081.3&4	170	3255	5.24 E-2	4.69 E-2
SP31.T3.1093.3&4	6950	802650	8.66 E-3	7.764E-3
SP115.T3.895.3&4	7790	1357850	5.88 E-3	5.27 E-3
SP116.T3.897.3&4	15335	1100800	1.39 E-2	1.25 E-2
SP117.T3.899.3&4	1585	190510	8.32 E-3	7.45 E-3
SP125.T3.913.3&4	420	62260	6.75 E-3	6.05 E-3
SP126.T3.915.3&4	2170	189735	1.14 E-2	1.02 E-2
SP129.T3.921.3&4	252675	10327725	2.44 E-2	2.19 E-2
SP141.T3.935.3&4	2335	941980	2.48 E-3	2.22 E-3
SP152.T3.959.3&4	5890	390130	1.51 E-2	1.35 E-2
SP162.T3.973.3&4	5580	180470	3.09 E-2	2.77 E-2
SP169.T3.987.3&4	10	14380	6.95 E-4	6.22 E-4
SP173.T3.991.3&4	890	28740	3.09 E-2	2.77 E-2
SP186.T3.1013.3&4	305	8370	3.64 E-2	3.26 E-2
SP196.T3.1025.3&4	395	6330	6.24 E-2	5.59 E-2
SP201.T3.1033.3&4	8855	1366620	6.48 E-3	5.81 E-3
SP210.T3.1043.3&4	3295	572080	5.76 E-3	5.16 E-3
RB24.B.1121.1&2	270	3660	7.38 E-2	6.61 E-2
RB24.B.1122.1&2	225	6755	4.96 E-2	4.44 E-2
RB24.B.1123.1&2	260	2285	1.13 E-1	1.01 E-1

Nominal weight 0.1mg entered for all samples.
Less than 10 counts recorded as 10.

*RB=Reagent blank,Batch24.Blank.Run no.

+ New Ratio= dose normalised ratio
=Ratio Glow1:Glow2 * $\frac{\text{Measured dose}}{2.5}$
=Ratio Glow1:Glow2 * 0.896

RUN SHEET

RUN NUMBER(S):BLANK1-50 DATE(S):24.10.88-9.11.88

GLASSWARE BLANKS

As a check on the cleaning procedure for the glassware, the following procedure was adopted.

Glassware cleaning procedure

All centrifuge tubes were washed in hot water containing Decon 90, rinsed twice with hot tap water, and shaken for 2 minutes in hot Decon solution in an ultrasonic bath. The washing was followed by a thorough rinsing procedure. The tubes were rinsed in hot running water, twice and then in de-ionised water, twice. They were then allowed to dry by inverting on a drying rack.

Glassware check

The clean glassware was rinsed with acetone , several small tubes and one large tube being rinsed with the same portion of acetone. The acetone was poured onto a clean disc in a settling tube and left to dry in the 55'C overnight. The discs were glowed the next day to 500'C at 6'C per second.

Results

Filename	TL 250-260'C	Notes
BLANK1	135	Following separation of
BLANK2	0	irradiated samples.
BLANK3	20	
BLANK4	5	New discs.
BLANK5	60	
BLANK6	15	
BLANK7	0	
BLANK8	3875	
BLANK9	65	Following separation of
BLANK10	220	unirradiated samples.
BLANK11	220	
BLANK12	690	New discs.
BLANK13	150	
BLANK14	535	
BLANK15	805	Following separation of
BLANK16	85	irradiated samples.
BLANK17	235	
BLANK18	560	Discs used once before.
BLANK19	4035	
BLANK20	380	
BLANK21	1300	Following separation of
BLANK22	755	unirradiated samples.
BLANK23	505	
BLANK24	2880	Discs used once before.
BLANK25	95	
BLANK26	1325	

RUN SHEET

RUN NUMBER(S): BLANK1-50 DATE(S): 24.10.88-9.11.88

Results

Filename	TL 250-260'C	Notes
BLANK27	0	Following separation of
BLANK28	530	irradiated samples.
BLANK29	3220	*contaminated from tweezers
BLANK30	110	New discs.
BLANK31	50	
BLANK32	835	
BLANK33	575	Following separation of
BLANK34	280	unirradiated samples.
BLANK35	0	
BLANK36	485	Discs used once before.
BLANK37	125	
BLANK38	30	
BLANK39	1550	Following separation of
BLANK40	0	irradiated samples.
BLANK41	135	
BLANK42	1275	New discs.
BLANK43	650	
BLANK44	1380	
BLANK45	655	Following separation of
BLANK46	235	unirradiated samples.
BLANK47	205	
BLANK48	90	Discs used once before.
BLANK49	5	
BLANK50	460	

DATE: 9.11.88-11.11.88

BACKGROUND COUNT

To obtain a measure of the background count, several test runs were performed with no disc on the heating plate.

Date	Filename	TL 250-260'C	Notes
9.11.88	TEST1	2755	Cleaned oven, acetone
9.11.88	TEST2	1085	
9.11.88	TEST3	-460	
9.11.88	TEST4	90	Cleaned oven, metal
9.11.88	TEST5	905	polish
9.11.88	TEST6	-25	
9.11.88	TEST7	-45	
9.11.88	TEST8	70	
11.11.88	TEST1	675	
11.11.88	TEST2	-220	

Most of the counts from the glassware were in the background range.

RUN SHEET

Microscopic examination of low sensitivity sample discs from Batches 20-24.

Results

Batch	Sample	Disc no.	Count	No. grains	Organic matter
20B	SP115	163	2215	2	no
20B	SP123	177	6100	10	yes
20I	SP123	178	6615	4	yes
20B	SP133	195	3020	1	yes
21I	SP113	162	3475	3	yes
21B	SP144	211	5170	3	no
21I	SP170	254	9780	10	yes
22B	SP181	277	3075	10	yes
22B	SP186	281	4205	15	no
22B	SP213	315	7195	35	no
23B	SP9	337	4935	2	yes
23I	SP10	340	8970	10	yes
23I	SP14	344	3660	6	yes
23B	SP37	373	2915	1	no
23B	SP41	375	4710	1	no
24	SP9	390	1130	2	yes
24	SP14	392	785	3	yes
24	SP20	393	3255	5	yes
24	SP186	406	8370	1	yes
24	SP196	407	6330	2	yes

A nominal weight of 0.1mg was entered for all of these samples.

A count of 10000 cps per mg over a 10 degree temperature band is equivalent to 100 counts per second. The background level is approx. 50 cps. Therefore it was decided to reject data with counts of less than 10000 cps per mg because this is approaching the sensitivity limit of the photomultiplier tube. Microscopic examination of these discs confirmed that there were very few mineral grains present.

RUN SHEET

Date: 21.11.88

Cleaning used stainless steel discs for reuse in density separation experiments.

Procedure

Used stainless steel discs were cleaned using a small electric drill with a brass brush and metal polish. After cleaning the discs were polished using the polishing head and then sprayed gently with the air duster to remove fluff and dust particles. The clean discs were irradiated for five minutes in the strontium 90 source, equivalent to a dose of 10 Gray. Immediately after irradiation the discs were glowed to 450 'C at 6'C per second. These discs were subsequently used for the deposition of mineral grains from avocado pears.

Results

Disc no.	TL 250-260'C	Notes
401	40	
402	10	
403	10	
404	75	
405	5	
406	0	
407	0	
408	0	
409	55	
410	0	
411	0	
412	320	
413	0	
414	0	
415	0	
416	0	
417	2070	Reject
418	0	
419	270	Reject
420	0	
421	0	
422	100	

0.1 mg mass entered for all discs.

It was concluded that the vast majority of discs were clean enough for reuse without fear of contamination problems.

RUN SHEET

Date: 24.11.88

Separation of mineral grains from avocado pears.

Procedure for cleaning glassware.

Large glass beakers (600ml) were thoroughly cleaned in hot Decon solution, rinsed in running hot water and then rinsed in deionised water, inverted and allowed to drain.

Settling tubes , ie flat bottomed test tubes, were rinsed in acetone and wiped with an acetone soaked tissue to remove any dust from the inside surface.

The clean beakers were rinsed in acetone and the solution transferred to a settling tube containing a clean stainless steel disc. The settling tubes were placed in the 55'C oven overnight to dry.

The next day the discs were glowed to 450'C using a nominal 0.1mg mass.

Results

Summary filename = AV.GLASS

Tube no.	Filename	TL 250-260'C	Subsequently used for avocado pear no
7	AV.GLASS.1	7370 *	AV1A
13	AV.GLASS.2	0	AV2A
15	AV.GLASS.3	0	AV3A
16	AV.GLASS.4	0	AV4A
18	AV.GLASS.5	0	AV5A
19	AV.GLASS.6	10	AV6A
20	AV.GLASS.7	20	AV7A
25	AV.GLASS.8	30	AV8A

* Sample disc was blank, therefore must have been disc contamination and not glassware contamination.

Microscopic examination of avocado pears

AV1A was examined under a microscope . Some dust particles could be seen on the surface near blemishes in the skin.

RUN SHEET

Date: 24.11.88

Separation of mineral grains from avocado pears.

Separation Procedure

All operations were carried out under safe-light conditions.

The avocado pear was placed pointed end down in a clean 600ml beaker and covered with deionised water. The beaker was covered in "cling-film" to prevent contamination from the atmosphere. The sample was shaken for 15 minutes in an ultrasonic bath. After shaking, the contents of the beaker were allowed to stand for 2 hours. The pear was removed, dried and placed in a clean resealable bag for storage in the refridgerator. The upper portion of the liquid was decanted and the lower 50 ml transferred to a large centrifuge tube. This was allowed to stand for 30 minutes, after which, the top 25 ml was removed using a pipette and the rest of the sample was centrifuged for 30 seconds. The aqueous layer was decanted , the sample was resuspended in acetone and centrifuged for 30 seconds. This procedure was repeated once more. A small amount of acetone was added and the sample divided between two settling tubes containing clean stainless steel discs. The acetone was dried off in the 55'C oven overnight.

After drying, half the discs were glowed immediately. The other half were irradiated for 1 hour (2 kGy) and then glowed. All the discs were given a 2 kGy normalisation dose. The ratio of the first glow to the second glow was taken. A nominal mass of 0.1 mg was entered for all samples.

Results

Summary filename = AVOCADO PEARS

Filename	Dose/ kGy	TL 250-260'C Glow 1	Glow 2	Glow 1:Glow 2
AV1A.1125.1&2	0	60	47640	1.25 E-3
AV2A.1127.1&2	0	780	245070	3.18 E-3
AV3A.1129.1&2	0	10	234970	4.25 E-5
AV4A.1131.1&2	0	865	349620	2.47 E-3
AV5A.1133.1&2	Centrifuge tube broke - sample lost			
AV6A.1135.1&2	0	380	101565	3.74 E-3
AV7A.1137.1&2	0	180	173570	1.04 E-3
AV8A.1139.1&2	0	2015	620620	3.25 E-3
AV1A.1126.1&2	10	10365	29365	3.50 E-1
AV2A.1128.1&2	10	119840	210030	5.70 E-1
AV3A.1130.1&2	10	105190	125180	8.40 E-1
AV4A.1132.1&2	10	369385	448120	8.20 E-1
AV5A.1134.1&2	Centrifuge tube broke - sample lost			
AV6A.1136.1&2	10	86890	119730	7.30 E-1
AV7A.1138.1&2	10	167565	206310	8.10 E-1
AV8A.1140.1&2	10	368495	374435	9.80 E-1

RUN SHEET

Date: 27.11.88

Separation of mineral grains from potatoes.

Separation Procedure

All operations were carried out under safe-light conditions.

One or two potatoes (depending on their size) were placed in a clean 600ml beaker and covered with deionised water. The beaker was covered in "cling-film" to prevent contamination from the atmosphere. The sample was shaken for 15 minutes in an ultrasonic bath. After shaking, the potatoes were removed and the suspension allowed to settle for 30 seconds before decanting off the upper layer. This portion contained only medium and fine grains and was allowed to stand for 40 minutes. The upper portion of the liquid was decanted and the lower 50 ml transferred to a large centrifuge tube. The sample was centrifuged for 30 seconds. The aqueous layer was decanted , the sample was resuspended in acetone and centrifuged for 30 seconds. This procedure was repeated once more. Approximately 30 ml acetone was added and four discs from each sample were prepared by adding 1ml suspension to tubes containing clean stainless steel discs. The remainder of the suspension was placed in another settling tube and stored in a cool, dark cupboard for future use. The sample discs were dried in the 55'C oven overnight.

After drying the discs were stored in a dark cupboard until required. Half the discs were irradiated for 3 minutes (0.1 kGy) on 29.11.88 and stored in the dark until 6.12.88, when they were glowed out together with their blanks. All the discs were given a 1 kGy normalisation dose on 8.12.88. The discs were preheated at 110'C for 15 minutes prior to the second glow. The ratio of the first glow to the second glow was taken. A nominal mass of 1 mg was entered for all samples.

Most of the discs had lost some grains between the first and second glow. This occurred during the reirradiation procedure.

RUN SHEET

Separation of mineral grains from potatoes.

Results

Summary of potato varieties used.

Sample no.	Variety		
P2	Record	Unwashed	2 potatoes
P3	Golden Wonder	Unwashed	1 potato
P4	Kerr's Pink	Unwashed	1 potato
P5	Romano	Washed	1 potato
P6	Unknown	Washed/peated	1 potato

Filename	Dose/ kGy	TL 250-260'C Glow 1	Glow 2	Glow 1:Glow 2
P2.1.1142.1&2	0	16468	2473423	6.66 E-3
P2.2.1142.1&2	0	35730	3143636	1.14 E-2*
P2.3.1142.1&2	0.1	359044	2177446	1.60 E-1
P2.4.1142.1&2	0.1	288237	1956621	1.50 E-1
P3.1.1143.1&2	0	7601	1782960	4.26 E-3
P3.2.1143.1&2	0	12393	1571446	7.89 E-3
P3.3.1143.1&2	0.1	183785	1097844	1.70 E-1
P3.4.1143.1&2	0.1	266690	1814826	1.50 E-1
P4.1.1144.1&2	0	2857	341965	8.35 E-3
P4.2.1144.1&2	0	2179	240509	9.06 E-3
P4.3.1144.1&2	0.1	238875	391251	6.00 E-2*
P4.4.1144.1&2	0.1	30022	174735	1.70 E-1
P5.1.1145.1&2	0	559	141787	3.94 E-3
P5.2.1145.1&2	0	653	126363	5.17 E-3
P5.3.1145.1&2	0.1	11167	87925	1.30 E-1
P5.4.1145.1&2	0.1	17178	137257	1.30 E-1
$P6.1.1146.1&2	0	1101	66070	1.67 E-2
$P6.2.1146.1&2	0	863	47323	1.82 E-2
$P6.3.1146.1&2	0.1	8178	68593	1.20 E-1
$P6.4.1146.1&2	0.1	9940	81365	1.20 E-1

* Data rejected. Some sample lost during Glow 1 and more lost during reirradiation.

$ Peaty sample dislodged from disc after drying, therefore redispensed using silicone grease.

Filename = Sample.Disc no.Run.Glow no.

RUN SHEET

Date: 27.11.88

TL growth of mineral grains from potatoes, soil & pure feldspar.

Preparation of sample discs - soil from potatoes.

All operations were carried out under safe-light conditions.

Two potatoes (variety - Estima) were placed in a clean 600ml beaker and covered with deionised water. The beaker was covered in "cling-film" to prevent contamination from the atmosphere. The sample was shaken for 15 minutes in an ultrasonic bath. After shaking, the potatoes were removed and the suspension allowed to settle for 30 seconds before decanting off the upper layer. This portion contained only medium and fine grains and was allowed to stand for 40 minutes. The upper portion of the liquid was decanted and the lower 50 ml transferred to a large centrifuge tube. The sample was centrifuged for 30 seconds. The aqueous layer was decanted , the sample was resuspended in acetone and centrifuged for 30 seconds. This procedure was repeated once more. Approximately 30 ml acetone was added and eighteen discs from each sample were prepared by adding 1ml suspension to tubes containing clean stainless steel discs. The remainder of the suspension was placed in another settling tube and stored in a cool, dark cupboard for future use. The sample discs were dried in the 55'C oven overnight.

Preparation of sample discs - soil and pure feldspar.

Samples of Elginhaugh soil (1mm sieved) and pure Microcline feldspar were obtained from the Dating lab. The samples were annealed at 400'C for 5 minutes, cooled in a fume cupboard and dispensed onto stainless steel discs using silicone grease as a contact adhesive.

Irradiation Procedure

Duplicate discs of soil from potatoes (P1), Elginhaugh soil (P8) and Microcline feldspar (P9) were packaged for irradiation by placing the discs on an adhesive strip, covering them individually with a polythene cap and wrapping them with cling film. These parcels were placed on a small petrie dish to prevent them from moving around. This procedure is intended to minimise loss of sample and prevent cross-contamination during the irradiation procedure.

The petrie dishes were wrapped in black polythene to prevent exposure to daylight during transport to and from the Co-60 source. These parcels were stacked on top of each other inside a cardboard tube which was placed in the centre of the irradiation cannister, so that all samples were, as far as possible in the same irradiation field. The samples were irradiated on 2.12.88 for the times shown on page R.174

RUN SHEET

IRRADIATION CHART Date:1.12.88 & 2.12.88

Batch 27

Required irradiation time	Time in	Time out	Time in source	Total irradiation time
3 minutes	15-18	15-21	3 min	3 min
6 minutes	15-24	15-27	3 min	6 min
15 minutes	15-30	15-39	9 min	15 min
30 minutes	15-42	15-57	15 min	30 min
1 hour	16-00	16-30	30 min	1 hour
2.5 hour	8-47	10-17	90 min	2.5 hour
5 hour	10-22	12-52	2.5 hour	5 hour
10 hour	12-57	15-57	3 hour	8 hour

Note: Batch 27 consisted of Microcline feldspar and Elginhaugh soil samples only. The sample discs with soil from potatoes were irradiated by a similar procedure in Batch 26 on 29.11.88

Glowing out the samples.

After irradiation the samples were stored in a dark cupboard until the whole set had been irradiated.

All of the feldspar samples and half of the soil samples were glowed out with a black filter in the photomultiplier tube to reduce the sensitivity by two orders of magnitude

A nominal mass of 5mg was entered for all samples.

The feldspar samples were repackaged and given a normalisation dose for 30 minutes (1 kGy). The discs were preheated for 30 minutes at 140'C before being glowed again. The ratio of Glow 1 : Glow 2 was taken for the 300-310'C integral because some of the 250-260' TL had been lost in the preheat, which was a little too severe.

The soil samples were given a 1 kGy normalisation dose followed by a preheat at 110'C for 15 minutes, before being glowed again without a black filter. The ratio of Glow 1: Glow 2 was taken for the 250-260' integral.

RUN SHEET

Results - Microcline feldspar (P9)

Filename	Dose/ kGy	TL 300-310'C Glow 1	Glow 2	Glow 1:Glow 2
P9.1.1149.1&2	0	0	57628	-
P9.2.1149.1&2	0	0	66970	-
P9.3.1149.1&2	0.1	15441	94712	0.16
P9.4.1149.1&2	0.1	11879	85297	0.14
P9.5.1149.1&2	0.2	18178	61641	0.29
P9.6.1149.1&2	0.2	50450	83873	0.60
P9.7.1149.1&2	0.5	47226	69751	0.68
P9.8.1149.1&2	0.5	96618	102728	0.94
P9.9.1149.1&2	1.0	126740	154189	0.82
P9.10.1149.1&2	1.0	131087	86494	1.52
P9.11.1149.1&2	2.0	136273	98909	1.38
P9.12.1149.1&2	2.0	174290	120044	1.45
P9.13.1149.1&2	5.0	184533	91837	2.01
P9.14.1149.1&2	5.0	139633	78485	1.78
P9.15.1149.1&2	10.0	257423	61442	- *
P9.16.1149.1&2	10.0	168754	55214	- *
P9.17.1149.1&2	16.0	229930	98712	2.01
P9.18.1149.1&2	16.0	208243	111094	1.78

* Much sample dislodged after Glow 1, therefore data rejected.

Results - Elginhaugh soil (P8)

Filename	Dose/ kGy	TL 250-260'C Glow 1	Glow 2	Glow 1:Glow 2
P8.1.1148.1&2	0	2	322490	-
P8.2.1148.1&2	0	0	-	-
P8.3.1148.1&2	0.1	38877	452023	8.60 E-2
P8.4.1148.1&2	0.1	93	-	-
P8.5.1148.1&2	0.2	59929	295149	2.03 E-1
P8.6.1148.1&2	0.2	476	-	-
P8.7.1148.1&2	0.5	244960	435958	5.60 E-1
P8.8.1148.1&2	0.5	1127	-	-
P8.9.1148.1&2	1.0	307113	359311	8.50 E-1
P8.10.1148.1&2	1.0	3933	-	-
P8.11.1148.1&2	2.0	373599	267961	1.39
P8.12.1148.1&2	2.0	4045	-	-
P8.13.1148.1&2	5.0	605507	262690	2.30
P8.14.1148.1&2	5.0	6575	-	-
P8.15.1148.1&2	10.0	493011	263287	1.87
P8.16.1148.1&2	10.0	7670	-	-
P8.17.1148.1&2	16.0	765400	379197	2.02
P8.18.1148.1&2	16.0	9494	-	-

Odd numbered discs glowed without black filter.
Even numbered discs glowed with black filter.

Filename = Sample no.Disc no.Run.Glow

RUN SHEET

Results - Soil from potatoes (P1)

Filename	Dose/ kGy	TL 250-260'C Glow 1	Glow 2	Glow 1:Glow 2
P1.1.1141.1&2	0	0	1382	-
P1.2.1141.1&2	0	0	-	-
P1.3.1141.1&2	0.1	19027	122366	1.60 E-1
P1.4.1141.1&2	0.1	107	-	-
P1.5.1141.1&2	0.2	66843	206079	3.20 E-1
P1.6.1141.1&2	0.2	193	-	-
P1.7.1141.1&2	0.5	123357	156057	7.90 E-1
P1.8.1141.1&2	0.5	376	-	-
P1.9.1141.1&2	1.0	193560	152891	1.27
P1.10.1141.1&2	1.0	923	-	-
P1.11.1141.1&2	2.0	243424	128548	1.89
P1.12.1141.1&2	2.0	1148	-	-
P1.13.1141.1&2	5.0	309152	130326	2.37
P1.14.1141.1&2	5.0	2653	-	-
P1.15.1141.1&2	10.0	355172	140917	2.52
P1.16.1141.1&2	10.0	2289	-	-
P1.17.1141.1&2	33.0	394293	135348	2.91
P1.18.1141.1&2	33.0	1808	-	-

Odd numbered discs glowed without black filter.
Even numbered discs glowed with black filter.

Filename = Sample no.Disc no.Run.Glow

The unnormalised data from the 250-260'C integral were plotted in a log/log distribution of photon count v time, together with the data from the 300-310'C integral from the Microcline feldspar. All the curves were the same general shape.

The ratios shown in the tables were plotted on another graph. Again, the curves had the same shape, but they also lay in the same position on the y-axis.

RUN SHEET

Exploratory TL of Egg and Crab Shell.

The major component of egg shell is calcium carbonate. Chitin (a polysaccharide) is the major component of crab shell, but this is made hard by the infiltration of calcium salts. As both these materials contain calcium salts, they should show TL properties.

Preparation of Egg Shell

A whole egg was irradiated for 1 hour (2 kGy) on 25.11.88. This was stored in the refrigerator, together with an unirradiated egg, for 1 week before use. Unfortunately they were not protected from the light. After 1 week of storage at 5'C the eggs were broken open and the inside discarded. It was noted that off-odours previously noticed in freshly irradiated eggs had disappeared.

The egg shells were washed in water, dried with tissues and crushed using a pestle and mortar with a hammering action rather than grinding. The shell membrane prevented adequate crushing, therefore the shell was broken into small pieces using the fingers. The shell membrane separated from the outer shell more easily in the irradiated egg than the blank.

The broken shell was dispensed onto clean stainless steel discs, sprayed with silicone grease, and glowed to 450'C at 6'C per second.

Preparation of Crab Shell.

The shell was broken into small pieces by hand and then crushed using a pestle and mortar without grinding. The sample was divided into two portions, one of which was irradiated to 5kGy, the other was set aside as a blank.

The irradiated sample and blank were dispensed onto stainless steel discs sprayed with silicone grease, and glowed to 450'C at 6'C per second.

Results

Filename	Dose/ kGy	Sample mass/mg	Specific TL 250-260' cps per mg
EGG SHELL.1.1150.1	0	14.12	Data lost
EGG SHELL.2.1150.1	0	11.12	76
EGG SHELL.3.1150.1	2	18.06	257
EGG SHELL.4.1150.1	2	25.82	309
CRAB SHELL.1.1151.1	0	5.19	5
CRAB SHELL.2.1151.1	0	8.57	0
CRAB SHELL.3.1151.1	5	4.39	4252
CRAB SHELL.4.1151.1	5	8.96	2159

Both egg shell and crab shell show TL properties.

SAMPLE LIST

Reference SP58	Pfifferlinge 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP59	Pfifferlinge 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP60	Pfifferlinge 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP61	Pfifferlinge 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP62	Pfifferlinge 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP63	Bohnenkraut 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP64	Bohnenkraut 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP65	Bohnenkraut 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP66	Bohnenkraut 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.

Reference SP67	Bohnenkraut 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP68	Curcuma 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP69	Curcuma 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP70	Curcuma 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP71	Curcuma 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP72	Curcuma 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP73	Ingwer 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP74	Ingwer 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP75	Ingwer 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.

Reference SP76	Ingwer 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP77	Ingwer 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP78	Majoran 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP79	Majoran 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP80	Majoran 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP81	Majoran 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP82	Majoran 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP83	Paprika 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP84	Paprika 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.

SAMPLE LIST

Reference SP85	Paprika 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP86	Paprika 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP87	Paprika 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP88	Pfeffer,schwarz 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP89	Pfeffer,schwarz 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP90	Pfeffer,schwarz 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP91	Pfeffer,schwarz 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP92	Pfeffer,schwarz 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP93	Salbei 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.

SAMPLE LIST

Reference SP93	Salbei 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP94	Salbei 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP95	Salbei 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP96	Salbei 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP97	Salbei 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP98	Sellerie saat 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP99	Sellerie saat 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP100	Sellerie saat 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP101	Sellerie saat 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.

SAMPLE LIST

Reference SP102	Sellerie saat 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP103	Thymian 1, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP104	Thymian 2, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP105	Thymian 3, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP106	Thymian 4, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.
Reference SP107	Thymian 5, (14.12.87) from the laboratory of L.Heide, Institute for Radiation Hygiene of the Federal Health Office, Ingolstadter Landstrasse, D-8042, Neuerberg,FRG.

SAMPLE LIST

Reference AV1 A&B	Avocado pears purchased from Safeway, East Kilbride, 23.11.88, 49p each. Carmel, Country of origin: Israel.
Reference AV2 A&B	Avocado pears purchased from Imrie, East Kilbride, 23.11.88, 68p each. Creta Sun, Country of origin (as marked on shelf): Spain.
Reference AV3 A&B	Avocado pears purchased from Presto, Kirkintilloch, 23.11.88, 49p each. Carmel, Country of origin: Israel.
Reference AV4 A&B	Avocado pears purchased from Gateway, Bishopbriggs , 23.11.88, 49p each. Pascual, Country of origin: Spain.
Reference AV5 A&B	Avocado pears purchased from Co-op, Kirkintilloch, 23.11.88, 39p each. Carmel, Country of origin: Israel.
Reference AV6 A&B	Avocado pears (black skinned variety) purchased from Tesco, Renfrew, 23.11.88, 42p each. Country of origin: South africa.
Reference AV7 A&B	Avocado pears purchased from Asda, Sommerston, 23.11.88. Carmel, Country of origin: Israel. Shelf label showed Fuerte Mexico.

SAMPLE LIST

Reference AV8 A&B	Avocado pears purchased from Asda, Sommerston, 23.11.88. Carmel, Country of origin: Israel. "Bio-top" organically grown.
Reference P1	Potatoes, variety: Estima, unwashed. Country of Origin: Scotland Purchased at Co-op Superstore, Kirkintilloch on 26.11.88. 5lb bag 59p.
Reference P2	Potatoes, variety: Record, unwashed. Country of Origin: Scotland Purchased at Co-op Superstore, Kirkintilloch on 26.11.88. 5lb bag 59p.
Reference P3	Potatoes, variety: Golden Wonder, unwashed. Country of Origin: Scotland Purchased at Co-op Superstore, Kirkintilloch on 26.11.88. 19p per pound.
Reference P4	Potatoes, variety: Kerrs Pink, unwashed. Country of Origin: Scotland Purchased at Co-op Superstore, Kirkintilloch on 26.11.88. 10p per pound.
Reference P5	Potatoes, variety: Romano, washed. Country of Origin: Scotland Purchased at Co-op Superstore, Kirkintilloch on 26.11.88. 12p per pound.
Reference P6	Potatoes, variety: Cara? washed & peated. Country of Origin: Scotland Purchased at Co-op Superstore, Kirkintilloch on 26.11.88. 10p per pound.
Reference P7	Potatoes, variety: Morene, washed. Country of Origin: Scotland Purchased at Co-op Superstore, Kirkintilloch on 26.11.88. 3 for 59p. Large potatoes for baking.
Reference P8	Elginhaugh soil. 1mm sieved. Sample obtained from dating lab.
Reference P9	RC169 Microcline feldspar. Sample obtained from dating lab.

BATCH LIST

Batch

B.5 Samples SP54-SP82 were irradiated for 4 hours in the 200TBq Co-60 source on 1.2.88. Four Harwell Red 4034 dosimeters were placed in/on the pack;
(i) 2 taped to the sides of the pack on the outer wrapper (1&2),
(ii) 2 inside the pack in the middle of the sample, one taped horizontally and one taped vertically (3&4)

Time in: 11-00 Time out: 15-00 Time elapsed:4h.

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.269	0.326	0.825	10.17	0.706
2	0.275	0.310	0.887	11.30	0.784
3	0.238	0.315	0.898	11.50	0.799
4	0.251	0.323	0.777	9.37	0.650

B.6 Samples SP83-SP107 were irradiated for 4 h in the 200TBq Co-60 source on 2.2.88. Four Harwell Red 4034 dosimeters were placed in/on the pack;
(i) 2 taped to the sides of the pack on the outer wrapper (1&2),
(ii) 2 inside the pack in the middle of the sample, one taped horizontally and one taped vertically (3&4)

Time in: 10-00 Time out: 14-00 Time elapsed:4h.

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.269	0.305	0.882	11.20	0.778
2	0.265	0.298	0.889	11.33	0.787
3	0.250	0.297	0.842	10.47	0.727
4	0.275	0.314	0.876	11.09	0.770

BATCH LIST

Batch

B.13 Samples SP233-SP234 were irradiated for 1 h in the 200TBq Co-60 source on 14.3.88. One Harwell Red 4034 dosimeter was placed in the pack;

Time in: 10-30 Time out: 11-30 Time elapsed: 1h.

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.060	0.345	0.174	2.31	0.642

B.14 Samples SP230-SP232 were irradiated for 4 h in the 200TBq Co-60 source on 14.3.88. One Harwell Red 4034 dosimeter was placed in the pack;

Time in: 10-30 Time out: 14-30 Time elapsed: 4h.

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.253	0.299	0.846	10.54	0.732

B.15 The samples named in the Batch Index on page 6 were irradiated for 4 hours in the 200TBq Co-60 source on 23.5.88. Five Harwell Red 4034 dosimeters were placed in/on the pack:
1 placed in the middle of the package,
2 taped to the top of the package,
3 taped to the bottom of the package,
4 & 5 taped to the sides of the package.
Overall dimensions of the package: 90mm*90mm*35mm.

Time in: 11-15 Time out: 15-15 Time elapsed: 4h.

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.2700	0.313	0.8626	10.84	0.753
2	0.2675	0.300	0.8917	11.38	0.791
3	0.2650	0.319	0.8307	10.27	0.713
4	0.2625	0.313	0.8387	10.41	0.723
5	0.2750	0.318	0.8648	10.88	0.756

Batch

B.18 Samples SP8, SP15, SP34B, SP45, SP235, & SP236 were irradiated for 4 hours in the 200TBq Co-60 source on 22.8.88. A Harwell Red 4034 dosimeter was placed in the middle of the pack.
Overall dimensions of the package:120mm*55mm*45mm.

Time in: 11-10 Time out: 15-10 Time elapsed:4h.

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.215	0.308	0.6967	8.09	0.562

B.19 The samples listed on pages B.8 & B.9 were irradiated for 4 hours in the 200TBq Co-60 source on 17.10.88. A Harwell Red 4034 dosimeter was placed in the middle of the pack (1).
The mineral discs from the density separated samples (both unirradiated and irradiated) were given an additional normalisation dose for 1 hour after being glowed out. This was carried out on 19.10.88. The blank discs being irradiated in the morning and the discs fom the previously irradiated samples being irradiated in the afternoon. A Harwell Red 4034 dosimeter was placed in each package (2 & 3).

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.274	0.340	0.806	9.84	0.684
2	0.040	0.289	0.138	2.03	0.564
3	0.055	0.316	0.174	2.31	0.642

BATCH LIST

Batch

B.22 The samples listed on pages B.12 & B.13 were irradiated for 4 hours in the 200TBq Co-60 source on 28.10.88. A Harwell Red 4034 dosimeter was placed in the middle of the pack (1).
The mineral discs from the density separated samples (both unirradiated and irradiated) were given an additional normalisation dose for 1 hour after being glowed out. This was carried out on 30.10.88. The blank discs being irradiated in the morning and the discs fom the previously irradiated samples being irradiated in the afternoon. A Harwell Red 4034 dosimeter was placed in each package (2 & 3).

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.235	0.317	0.741	7.75	0.609
2	0.045	0.331	0.136	2.02	0.545
3	0.043	0.330	0.129	1.96	0.560

B.23 The samples listed on pages B.13 & B.14 were irradiated for 4 hours in the 200TBq Co-60 source on 2.10.88. A Harwell Red 4034 dosimeter was placed in the middle of the pack (1).
The mineral discs from the density separated samples (both unirradiated and irradiated) were given an additional normalisation dose for 1 hour after being glowed out. This was carried out on 4.11.88 for the blank discs and on 7.11.88 for the discs from the previously irradiated samples. A Harwell Red 4034 dosimeter was placed in each package (2 & 3).

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.242	0.348	0.695	8.07	0.560
2	0.043	0.315	0.137	2.02	0.562
3	0.051	0.333	0.153	2.15	0.596

Batch

B.24 The mineral discs from the density separated samples listed on page B.14 were irradiated for 1 hour in the 200TBq Co-60 source. These samples had not previously been irradiated. A Harwell Red 4034 dosimeter was placed in the package (1).

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.051	0.309	0.165	2.24	0.622

B.25 The minerals shaken from the avocado pear samples listed on page B.15 were irradiated for 1 hour in the 200TBq Co-60 source on 25.11.88. A Harwell Red 4034 dosimeter was placed in the middle of the pack (1).

These discs together with the blank discs were given an additional normalisation dose for 1 hour after being glowed out on 25.11.88. A Harwell Red 4034 dosimeter was placed in each package (2 & 3).

Dosimeter no.	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	0.008	0.367	0.022	1.21	0.335
2	0.031	0.317	0.098	1.73	0.482
3	0.043	0.321	0.132	1.99	0.556

B.26 The minerals shaken from the potato samples listed on page B.15 were irradiated for the times shown below in the 200TBq Co-60 source on 29.11.88. Several Harwell Red 4034 dosimeters were placed in the packs.

These discs together with the blank discs were given an additional normalisation dose for 1 hour after being glowed out on 7.12.88.

Dosimeter no.	Time	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
1	3 min	0.0020	0.342	0.0058	1.10	6.102*
2	6 min	0.0020	0.327	0.0061	1.10	3.057*
3	15 min	0.0025	0.342	0.0073	1.11	1.231*
4	30 min	0.0125	0.324	0.0386	1.32	0.732*
5	60 min	0.0380	0.289	0.1315	1.98	0.551
6	2.5 h	0.1280	0.289	0.4429	4.83	0.537
7	5.0 h	0.3010	0.302	0.9967	13.50	0.750
8	17.0 h	0.6700	0.302	2.2185	67.61	1.105
9	3 min	0.0010	0.334	0.0030	1.08	6.001*
10	3 min	0.0005	0.290	0.0017	1.07	5.954*

* Outside the useful range of these dosimeters.

Batch

B.27 The mineral discs prepared from samples P8 & P9 were irradiated for the times shown below in the 200TBq Co-60 source on 2.12.88. Several Harwell Red 4034 dosimeters were placed in the packs.

These discs together with the blank discs were given an additional normalisation dose for 1 hour after being glowed out on 6.12.88 & 8.12.88.

Dosimeter no.	Time	Absorbance A	Disc Thickness Dx cm	Specific Absorbance A/Dx	Dose kGy	Dose Rate Gy/s
n/a	3 min				0.1	
n/a	6 min				0.2	
n/a	15 min				0.5	
n/a	30 min				1.0	
4	60 min	0.0390	0.298	0.131	1.98	0.549
3	2.5 h	0.1325	0.314	0.422	4.60	0.511
2	5.0 h	0.2960	0.344	0.860	10.80	0.599
1	8.0 h	0.3790	0.302	1.255	19.95	0.693
5	8.0 h	0.4350	0.330	1.318	21.83	0.758

BATCH INDEX

Last update: 23.6.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.12	1.3.88	9.5-11.6	SP210	463,464
B.12	1.3.88	9.5-11.6	SP211	465,466
B.12	1.3.88	9.5-11.6	SP212	467,468
B.12	1.3.88	9.5-11.6	SP213	469,470
B.12	1.3.88	9.5-11.6	SP214	471,472
B.12	1.3.88	9.5-11.6	SP215	473,474
B.12	1.3.88	9.5-11.6	SP216	475,476
B.12	1.3.88	9.5-11.6	SP217	477,478
B.12	1.3.88	9.5-11.6	SP218	479,480
B.12	1.3.88	9.5-11.6	SP219	481,482
B.12	1.3.88	9.5-11.6	SP220	483,484
B.12	1.3.88	9.5-11.6	SP221	485,486
B.12	1.3.88	9.5-11.6	SP222	487,488
B.12	1.3.88	9.5-11.6	SP223	489,490
B.12	1.3.88	9.5-11.6	SP224	491,492
B.12	1.3.88	9.5-11.6	SP225	493,494
B.12	1.3.88	9.5-11.6	SP226	495,496
B.12	1.3.88	9.5-11.6	SP227	497,498
B.12	1.3.88	9.5-11.6	SP228	499,500
B.12	1.3.88	9.5-11.6	SP229	501,502
B.13	14.3.88	2.3	SP233	509,510
B.13	14.3.88	2.3	SP234	511,512
B.14	14.3.88	10.5	SP230	503,504
B.14	14.3.88	10.5	SP231	505,506
B.14	14.3.88	10.5	SP232	507,508
B.15	23.5.88	10.3-11.4	SP8	511-514
B.15	23.5.88	10.3-11.4	SP15	515-518
B.15	23.5.88	10.3-11.4	SP20	519-522
B.15	23.5.88	10.3-11.4	SP23	523-526
B.15	23.5.88	10.3-11.4	SP34A	527-530
B.15	23.5.88	10.3-11.4	SP35	531-534
B.15	23.5.88	10.3-11.4	SP36	535-538
B.15	23.5.88	10.3-11.4	SP41	539-542
B.15	23.5.88	10.3-11.4	SP8	543,544
B.15	23.5.88	10.3-11.4	SP11	545,546
B.15	23.5.88	10.3-11.4	SP15	547,548
B.15	23.5.88	10.3-11.4	SP20	549,550
B.15	23.5.88	10.3-11.4	SP23	551,552
B.15	23.5.88	10.3-11.4	SP34A	553,554
B.15	23.5.88	10.3-11.4	SP35	555,556
B.15	23.5.88	10.3-11.4	SP36	557,558
B.15	23.5.88	10.3-11.4	SP41	559,560
B.15	23.5.88	10.3-11.4	SP16	561,562
B.15	23.5.88	10.3-11.4	SP45	563,564
B.15	23.5.88	10.3-11.4	SP40B	565,566

BATCH INDEX

Last update:23.6.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.16	30.5.88	10.3-11.4	SP226	567-570
B.16	30.5.88	10.3-11.4	SP10	571-574
B.16	30.5.88	10.3-11.4	SP37	575-578
B.16	30.5.88	10.3-11.4	SP227	579-582
B.16	30.5.88	10.3-11.4	SP124	583-586
B.16	30.5.88	10.3-11.4	SP127	587-590
B.16	30.5.88	10.3-11.4	SP7	591-594
B.16	30.5.88	10.3-11.4	SP9	595-598
B.16	30.5.88	10.3-11.4	SP139	599-602
B.16	30.5.88	10.3-11.4	SP31	603-606
B.16	30.5.88	10.3-11.4	SP163	607-610
B.16	30.5.88	10.3-11.4	SP15	611-614
B.16	30.5.88	10.3-11.4	SP149	615-618
B.16	30.5.88	10.3-11.4	SP129	619-622
B.16	30.5.88	10.3-11.4	SP120	623-626
B.16	30.5.88	10.3-11.4	SP27	627-630
B.17	6.6.88	7.7-10.2	SP171	631,632,727,728
B.17	6.6.88	7.7-10.2	SP6	633,634,729,730
B.17	6.6.88	7.7-10.2	SP109	635,636,731,732
B.17	6.6.88	7.7-10.2	SP119	637,638,733,734
B.17	6.6.88	7.7-10.2	SP146	639,640,735,736
B.17	6.6.88	7.7-10.2	SP155	641,642,737,738
B.17	6.6.88	7.7-10.2	SP172	643,644,739,740
B.17	6.6.88	7.7-10.2	SP128	645,646,741,742
B.17	6.6.88	7.7-10.2	SP153	647,648,743,744
B.17	6.6.88	7.7-10.2	SP188	649,650,745,746
B.17	6.6.88	7.7-10.2	SP108	651,652,747,748
B.17	6.6.88	7.7-10.2	SP154	653,654,749,750
B.17	6.6.88	7.7-10.2	SP189	655,656,751,752
B.17	6.6.88	7.7-10.2	SP17	657,658,753,754
B.17	6.6.88	7.7-10.2	SP111	659,660,755,756
B.17	6.6.88	7.7-10.2	SP145	661,662,757,758
B.17	6.6.88	7.7-10.2	SP148	663,664,759,760
B.17	6.6.88	7.7-10.2	SP191	665,666,761,762
B.17	6.6.88	7.7-10.2	SP174	667,668,763,764
B.17	6.6.88	7.7-10.2	SP176	669,670,765,766
B.17	6.6.88	7.7-10.2	SP11	671,672,767,768
B.17	6.6.88	7.7-10.2	SP110	673,674,769,770
B.17	6.6.88	7.7-10.2	SP157	675,676,771,772
B.17	6.6.88	7.7-10.2	SP131	677,678,773,774
B.17	6.6.88	7.7-10.2	SP13	679,680,775,776
B.17	6.6.88	7.7-10.2	SP122	681,682,777,778
B.17	6.6.88	7.7-10.2	SP26	683,684,779,780
B.17	6.6.88	7.7-10.2	SP167	685,686,781,782
B.17	6.6.88	7.7-10.2	SP114	687,688,783,784
B.17	6.6.88	7.7-10.2	SP214	689,690,785,786
B.17	6.6.88	7.7-10.2	SP18	691,692,787,788
B.17	6.6.88	7.7-10.2	SP19	693,694,789,790

BATCH INDEX

Last update:8.11.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.17	6.6.88	7.7-10.2	SP216	695,696,791,792
B.17	6.6.88	7.7-10.2	SP30	697,698,793,794
B.17	6.6.88	7.7-10.2	SP34B	699,700,795,796
B.17	6.6.88	7.7-10.2	SP24	701,702,797,798
B.17	6.6.88	7.7-10.2	SP136	703,704,799,800
B.17	6.6.88	7.7-10.2	SP159	705,706,801,802
B.17	6.6.88	7.7-10.2	SP220	707,708,803,804
B.17	6.6.88	7.7-10.2	SP165	709,710,805,806
B.17	6.6.88	7.7-10.2	SP217	711,712,807,808
B.17	6.6.88	7.7-10.2	SP215	713,714,809,810
B.17	6.6.88	7.7-10.2	SP198	715,716,811,812
B.17	6.6.88	7.7-10.2	SP140	717,718,813,814
B.17	6.6.88	7.7-10.2	SP203	719,720,815,816
B.17	6.6.88	7.7-10.2	SP29	721,722,817,818
B.17	6.6.88	7.7-10.2	SP161	723,724,819,820
B.17	6.6.88	7.7-10.2	SP137	725,726,821,822
B.18	22.8.88	8.09	SP8	823,824
B.18	22.8.88	8.09	SP15	825,826
B.18	22.8.88	8.09	SP34B	827,828
B.18	22.8.88	8.09	SP45	829,830
B.18	22.8.88	8.09	SP235	831,832
B.18	22.8.88	8.09	SP236	833,834
B.19	17.10.88	0,9.84	SP5	835.1,836.1
B.19	19.10.88	2.03,2.31	SP5	835.2,836.2
B.19	17.10.88	0,9.84	SP6	837.1,838.1
B.19	19.10.88	2.03,2.31	SP6	837.2,838.2
B.19	17.10.88	0,9.84	SP7	839.1,840.1
B.19	19.10.88	2.03,2.31	SP7	839.2,840.2
B.19	17.10.88	0,9.84	SP8	841.1,842.1
B.19	19.10.88	2.03,2.31	SP8	841.2,842.2
B.19	17.10.88	0,9.84	SP9	843.1,844.1
B.19	19.10.88	2.03,2.31	SP9	843.2,844.2
B.19	17.10.88	0,9.84	SP10	845.1,846.1
B.19	19.10.88	2.03,2.31	SP10	845.2,846.2
B.19	17.10.88	0,9.84	SP12	847.1,848.1
B.19	19.10.88	2.03,2.31	SP12	847.2,848.2
B.19	17.10.88	0,9.84	SP14	849.1,850.1
B.19	19.10.88	2.03,2.31	SP14	849.2,850.2
B.19	17.10.88	0,9.84	SP15	851.1,852.1
B.19	19.10.88	2.03,2.31	SP15	851.2,852.2
B.19	17.10.88	0,9.84	SP17	853.1,854.1
B.19	19.10.88	2.03,2.31	SP17	853.2,854.2
B.19	17.10.88	0,9.84	SP20	855.1,856.1
B.19	19.10.88	2.03,2.31	SP20	855.2,856.2
B.19	17.10.88	0,9.84	SP22	857.1,858.1
B.19	19.10.88	2.03,2.31	SP22	857.2,858.2
B.19	17.10.88	0,9.84	SP23	859.1,860.1
B.19	19.10.88	2.03,2.31	SP23	859.2,860.2

BATCH INDEX

Last update:8.11.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.19	17.10.88	0,9.84	SP25	861.1,862.1
B.19	19.10.88	2.03,2.31	SP25	861.2,862.2
B.19	17.10.88	0,9.84	SP27	863.1,864.1
B.19	19.10.88	2.03,2.31	SP27	863.2,864.2
B.19	17.10.88	0,9.84	SP28	865.1,866.1
B.19	19.10.88	2.03,2.31	SP28	865.2,866.2
B.19	17.10.88	0,9.84	SP31	867.1,868.1
B.19	19.10.88	2.03,2.31	SP31	867.2,868.2
B.19	17.10.88	0,9.84	SP32	869.1,870.1
B.19	19.10.88	2.03,2.31	SP32	869.2,870.2
B.19	17.10.88	0,9.84	SP33	871.1,872.1
B.19	19.10.88	2.03,2.31	SP33	871.2,872.2
B.19	17.10.88	0,9.84	SP34A	873.1,874.1
B.19	19.10.88	2.03,2.31	SP34A	873.2,874.2
B.19	17.10.88	0,9.84	SP35	875.1,876.1
B.19	19.10.88	2.03,2.31	SP35	875.2,876.2
B.19	17.10.88	0,9.84	SP36	877.1,878.1
B.19	19.10.88	2.03,2.31	SP36	877.2,878.2
B.19	17.10.88	0,9.84	SP37	879.1,880.1
B.19	19.10.88	2.03,2.31	SP37	879.2,880.2
B.19	17.10.88	0,9.84	SP41	881.1,882.1
B.19	19.10.88	2.03,2.31	SP41	881.2,882.2
B.19	17.10.88	0,9.84	SP108	883.1,884.1
B.19	19.10.88	2.03,2.31	SP108	883.2,884.2
B.19	17.10.88	0,9.84	RB19.B/I	885.1,886.1
B.19	19.10.88	2.03,2.31	RB19.B/I	885.2,886.2
B.19	17.10.88	0	RB19.I	888.1
B.19	19.10.88	2.31	RB19.I	888.2
B.20	20.10.88	0,9.03	SP109	887.1,888.1
B.20	22.10.88	2.21,2.23	SP109	887.2,888.2
B.20	20.10.88	0,9.03	SP111	889.1,890.1
B.20	22.10.88	2.21,2.23	SP111	889.2,890.2
B.20	20.10.88	0,9.03	SP112	891.1,892.1
B.20	22.10.88	2.21,2.23	SP112	891.2,892.2
B.20	20.10.88	0,9.03	SP113	893.1,894.1
B.20	22.10.88	2.21,2.23	SP113	893.2,894.2
B.20	20.10.88	0,9.03	SP115	895.1,896.1
B.20	22.10.88	2.21,2.23	SP115	895.2,896.2
B.20	20.10.88	0,9.03	SP116	897.1,898.1
B.20	22.10.88	2.21,2.23	SP116	897.2,898.2
B.20	20.10.88	0,9.03	SP117	899.1,900.1
B.20	22.10.88	2.21,2.23	SP117	899.2,900.2
B.20	20.10.88	0,9.03	SP118	901.1,902.1
B.20	22.10.88	2.21,2.23	SP118	901.2,902.2
B.20	20.10.88	0,9.03	SP119	903.1,904.1
B.20	22.10.88	2.21,2.23	SP119	903.2,904.2
B.20	20.10.88	0,9.03	SP120	905.1,906.1
B.20	22.10.88	2.21,2.23	SP120	905.2,906.2

BATCH INDEX

Last update:8.11.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.20	20.10.88	0,9.03	SP121	907.1,908.1
B.20	22.10.88	2.21,2.23	SP121	907.2,908.2
B.20	20.10.88	0,9.03	SP123	909.1,910.1
B.20	22.10.88	2.21,2.23	SP123	909.2,910.2
B.20	20.10.88	0,9.03	SP124	911.1,912.1
B.20	22.10.88	2.21,2.23	SP124	911.2,912.2
B.20	20.10.88	0,9.03	SP125	913.1,914.1
B.20	22.10.88	2.21,2.23	SP125	913.2,914.2
B.20	20.10.88	0,9.03	SP126	915.1,916.1
B.20	22.10.88	2.21,2.23	SP126	915.2,916.2
B.20	20.10.88	0,9.03	SP127	917.1,918.1
B.20	22.10.88	2.21,2.23	SP127	917.2,918.2
B.20	20.10.88	0,9.03	SP128	919.1,920.1
B.20	22.10.88	2.21,2.23	SP128	919.2,920.2
B.20	20.10.88	0,9.03	SP129	921.1,922.1
B.20	22.10.88	2.21,2.23	SP129	921.2,922.2
B.20	20.10.88	0,9.03	SP130	923.1,924.1
B.20	22.10.88	2.21,2.23	SP130	923.2,924.2
B.20	20.10.88	0,9.03	SP132	925.1,926.1
B.20	22.10.88	2.21,2.23	SP132	925.2,926.2
B.20	20.10.88	0,9.03	SP133	927.1,928.1
B.20	22.10.88	2.21,2.23	SP133	927.2,928.2
B.20	20.10.88	0,9.03	SP135	929.1,930.1
B.20	22.10.88	2.21,2.23	SP135	929.2,930.2
B.20	20.10.88	0,9.03	SP138	931.1,932.1
B.20	22.10.88	2.21,2.23	SP138	931.2,932.2
B.20	20.10.88	0,9.03	SP139	933.1,934.1
B.20	22.10.88	2.21,2.23	SP139	933.2,934.2
B.20	20.10.88	0,9.03	SP141	935.1,936.1
B.20	22.10.88	2.21,2.23	SP141	935.2,936.2
B.20	20.10.88	0,9.03	RB20.B/I	937.1,938.1
B.20	22.10.88	2.21,2.23	RB20.B/I	937.2,938.2
B.20	20.10.88	0	RB20.I2	940.1
B.20	22.10.88	2.23	RB20.I2	940.2
B.20	20.10.88	0	RB20.I3	942.1
B.20	22.10.88	2.23	RB20.I3	942.2
B.21	25.10.88	7.29	SP113	894.1
B.21	27.10.88	1.84	SP113	894.2
B.21	25.10.88	7.29	SP135	930.1
B.21	27.10.88	1.84	SP135	930.2
B.21	25.10.88	0,7.29	SP144	943.1,944.1
B.21	27.10.88	2.12,1.84	SP144	943.2,944.2
B.21	25.10.88	0,7.29	SP145	945.1,946.1
B.21	27.10.88	2.12,1.84	SP145	945.2,946.2
B.21	25.10.88	0,7.29	SP146	947.1,948.1
B.21	27.10.88	2.12,1.84	SP146	947.2,948.2
B.21	25.10.88	0,7.29	SP147A	949.1,950.1
B.21	27.10.88	2.12,1.84	SP147A	949.2,950.2
B.21	25.10.88	0,7.29	SP147B	951.1,952.1
B.21	27.10.88	2.12,1.84	SP147B	951.2,952.2

BATCH INDEX

Last update:8.11.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.21	25.10.88	0,7.29	SP149	953.1,954.1
B.21	27.10.88	2.12,1.84	SP149	953.2,954.2
B.21	25.10.88	0,7.29	SP150	955.1,956.1
B.21	27.10.88	2.12,1.84	SP150	955.2,956.2
B.21	25.10.88	0,7.29	SP151	957.1,958.1
B.21	27.10.88	2.12,1.84	SP151	957.2,958.2
B.21	25.10.88	0,7.29	SP152	959.1,960.1
B.21	27.10.88	2.12,1.84	SP152	959.2,960.2
B.21	25.10.88	0,7.29	SP153	961.1,962.1
B.21	27.10.88	2.12,1.84	SP153	961.2,962.2
B.21	25.10.88	0,7.29	SP154	963.1,964.1
B.21	27.10.88	2.12,1.84	SP154	963.2,964.2
B.21	25.10.88	0,7.29	SP155	965.1,966.1
B.21	27.10.88	2.12,1.84	SP155	965.2,966.2
B.21	25.10.88	0,7.29	SP156	967.1,968.1
B.21	27.10.88	2.12,1.84	SP156	967.2,968.2
B.21	25.10.88	0,7.29	SP158	969.1,970.1
B.21	27.10.88	2.12,1.84	SP158	969.2,970.2
B.21	25.10.88	0,7.29	SP160	971.1,972.1
B.21	27.10.88	2.12,1.84	SP160	971.2,972.2
B.21	25.10.88	0,7.29	SP162	973.1,974.1
B.21	27.10.88	2.12,1.84	SP162	973.2,974.2
B.21	25.10.88	0,7.29	SP163	975.1,976.1
B.21	27.10.88	2.12,1.84	SP163	975.2,976.2
B.21	25.10.88	0,7.29	SP164	977.1,978.1
B.21	27.10.88	2.12,1.84	SP164	977.2,978.2
B.21	25.10.88	0,7.29	SP166	979.1,980.1
B.21	27.10.88	2.12,1.84	SP166	979.2,980.2
B.21	25.10.88	0,7.29	SP168	981.1,982.1
B.21	27.10.88	2.12,1.84	SP168	981.2,982.2
B.21	25.10.88	0,7.29	SP169	983.1,984.1
B.21	27.10.88	2.12,1.84	SP169	983.2,984.2
B.21	25.10.88	0,7.29	SP170	985.1,986.1
B.21	27.10.88	2.12,1.84	SP170	985.2,986.2
B.21	25.10.88	0,7.29	SP171	987.1,988.1
B.21	27.10.88	2.12,1.84	SP171	987.2,988.2
B.21	25.10.88	0,7.29	SP172	989.1,990.1
B.21	27.10.88	2.12,1.84	SP172	989.2,990.2
B.21	25.10.88	0,7.29	SP173	991.1,992.1
B.21	27.10.88	2.12,1.84	SP173	991.2,992.2
B.21	25.10.88	0	RB21.B/I	993.1,994.1
B.21	27.10.88	2.12,1.84	RB21.B/I	993.2,994.2
B.21	25.10.88	0	RB21.B/I	995.1,996.1
B.21	27.10.88	2.12,1.84	RB21.B/I	995.2,996.2
B.21	25.10.88	0	RB21.B/I	997.1,998.1
B.21	27.10.88	2.12,1.84	RB21.B/I	997.2,998.2
B.21	25.10.88	0	RB21.B/I	997.1,998.1
B.21	27.10.88	2.12,1.84	RB21.B/I	997.2,998.2
B.21	25.10.88	0	RB21.B	999.1
B.21	27.10.88	2.12	RB21.B	999.2

BATCH_INDEX

Last_update:8.11.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.22	28.10.88	7.75	SP121	908.1
B.22	30.10.88	1.96	SP121	908.2
B.22	28.10.88	0,7.75	SP177	1001.1,1002.1
B.22	30.10.88	2.02,1.96	SP177	1001.2,1002.2
B.22	28.10.88	0,7.75	SP178	1003.1,1004.1
B.22	30.10.88	2.02,1.96	SP178	1003.2,1004.2
B.22	28.10.88	0,7.75	SP179	1005.1,1006.1
B.22	30.10.88	2.02,1.96	SP179	1005.2,1006.2
B.22	28.10.88	0,7.75	SP180	1007.1,1008.1
B.22	30.10.88	2.02,1.96	SP180	1007.2,1008.2
B.22	28.10.88	0,7.75	SP181	1009.1,1010.1
B.22	30.10.88	2.02,1.96	SP181	1009.2,1010.2
B.22	28.10.88	0,7.75	SP185	1011.1,1012.1
B.22	30.10.88	2.02,1.96	SP185	1011.2,1012.2
B.22	28.10.88	0,7.75	SP186	1013.1,1014.1
B.22	30.10.88	2.02,1.96	SP186	1013.2,1014.2
B.22	28.10.88	0,7.75	SP188	1015.1,1016.1
B.22	30.10.88	2.02,1.96	SP188	1015.2,1016.2
B.22	28.10.88	0,7.75	SP189	1017.1,1018.1
B.22	30.10.88	2.02,1.96	SP189	1017.2,1018.2
B.22	28.10.88	0,7.75	SP190	1019.1,1020.1
B.22	30.10.88	2.02,1.96	SP190	1019.2,1020.2
B.22	28.10.88	0,7.75	SP192	1021.1,1022.1
B.22	30.10.88	2.02,1.96	SP192	1021.2,1022.2
B.22	28.10.88	0,7.75	SP194	1023.1,1024.1
B.22	30.10.88	2.02,1.96	SP194	1023.2,1024.2
B.22	28.10.88	0,7.75	SP196	1025.1,1026.1
B.22	30.10.88	2.02,1.96	SP196	1025.2,1026.2
B.22	28.10.88	0,7.75	SP197	1027.1,1028.1
B.22	30.10.88	2.02,1.96	SP197	1027.2,1028.2
B.22	28.10.88	0,7.75	SP199	1029.1,1030.1
B.22	30.10.88	2.02,1.96	SP199	1029.2,1030.2
B.22	28.10.88	0,7.75	SP200	1031.1,1032.1
B.22	30.10.88	2.02,1.96	SP200	1031.2,1032.2
B.22	28.10.88	0,7.75	SP201	1033.1,1034.1
B.22	30.10.88	2.02,1.96	SP201	1033.2,1034.2
B.22	28.10.88	0,7.75	SP202	1035.1,1036.1
B.22	30.10.88	2.02,1.96	SP202	1035.2,1036.2
B.22	28.10.88	0,7.75	SP204	1037.1,1038.1
B.22	30.10.88	2.02,1.96	SP204	1037.2,1038.2
B.22	28.10.88	0,7.75	SP205	1039.1,1040.1
B.22	30.10.88	2.02,1.96	SP205	1039.2,1040.2
B.22	28.10.88	0,7.75	SP206	1041.1,1042.1
B.22	30.10.88	2.02,1.96	SP206	1041.2,1042.2
B.22	28.10.88	0,7.75	SP210	1043.1,1044.1
B.22	30.10.88	2.02,1.96	SP210	1043.2,1044.2
B.22	28.10.88	0,7.75	SP211	1045.1,1046.1
B.22	30.10.88	2.02,1.96	SP211	1045.2,1046.2
B.22	28.10.88	0,7.75	SP213	1047.1,1048.1
B.22	30.10.88	2.02,1.96	SP213	1047.2,1048.2

BATCH INDEX Last update:8.11.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.22	28.10.88	0,7.75	SP218	1049.1,1050.1
B.22	30.10.88	2.02,1.96	SP218	1049.2,1050.2
B.22	28.10.88	0	RB22.B/I	1051.1,1052.1
B.22	30.10.88	2.02,1.96	RB22.B/I	1051.2,1052.2
B.22	28.10.88	0	RB22.B/I	1053.1,1054.1
B.22	30.10.88	2.02,1.96	RB22.B/I	1053.2,1054.2
B.22	28.10.88	0	RB22.B/I	1055.1,1056.1
B.22	30.10.88	2.02,1.96	RB22.B/I	1055.2,1056.2
B.22	28.10.88	0	RB22.B/I	1057.1,1058.1
B.22	30.10.88	2.02,1.96	RB22.B/I	1057.2,1058.2
B.22	28.10.88	0	RB22.B	1059.1
B.22	30.10.88	2.02,1.96	RB22.B	1059.2
B.23	2.11.88	0,8.07	SP5	1061.1,1062.1
B.23	4/7.11.88	2.02,2,15	SP5	1061.2,1062.2
B.23	2.11.88	0,8.07	SP6	1063.1,1064.1
B.23	4/7.11.88	2.02,2.15	SP6	1063.2,1064.2
B.23	2.11.88	0,8.07	SP7	1065.1,1066.1
B.23	4/7.11.88	2.02,2.15	SP7	1065.2,1066.2
B.23	2.11.88	0,8.07	SP8	1067.1,1068.1
B.23	4/7.11.88	2.02,2.15	SP8	1067.2,1068.2
B.23	2.11.88	0,8.07	SP9	1069.1,1070.1
B.23	4/7.11.88	2.02,2.15	SP9	1069.2,1070.2
B.23	2.11.88	0,8.07	SP10	1071.1,1072.1
B.23	4/7.11.88	2.02,2.15	SP10	1071.2,1072.2
B.23	2.11.88	0,8.07	SP12	1073.1,1074.1
B.23	4/7.11.88	2.02,2.15	SP12	1073.2,1074.2
B.23	2.11.88	0,8.07	SP14	1075.1,1076.1
B.23	4/7.11.88	2.02,2.15	SP14	1075.2,1076.2
B.23	2.11.88	0,8.07	SP15	1077.1,1078.1
B.23	4/7.11.88	2.02,2.15	SP15	1077.2,1078.2
B.23	2.11.88	0,8.07	SP17	1079.1,1080.1
B.23	4/7.11.88	2.02,2.15	SP17	1079.2,1080.2
B.23	2.11.88	0,8.07	SP20	1081.1,1082.1
B.23	4/7.11.88	2.02,2,15	SP20	1081.2,1082.2
B.23	2.11.88	0,8.07	SP22	1083.1,1084.1
B.23	4/7.11.88	2.02,2.15	SP22	1083.2,1084.2
B.23	2.11.88	0,8.07	SP23	1085.1,1086.1
B.23	4/7.11.88	2.02,2.15	SP23	1085.2,1086.2
B.23	2.11.88	0,8.07	SP25	1087.1,1088.1
B.23	4/7.11.88	2.02,2.15	SP25	1087.2,1088.2
B.23	2.11.88	0,8.07	SP27	1089.1,1090.1
B.23	4/7.11.88	2.02,2.15	SP27	1089.2,1090.2
B.23	2.11.88	0,8.07	SP28	1091.1,1092.1
B.23	4/7.11.88	2.02,2.15	SP28	1091.2,1092.2
B.23	2.11.88	0,8.07	SP31	1093.1,1094.1
B.23	4/7.11.88	2.02,2.15	SP31	1093.2,1094.2
B.23	2.11.88	0,8.07	SP32	1095.1,1096.1
B.23	4/7.11.88	2.02,2.15	SP32	1095.2,1096.2

BATCH INDEX

Last update:14.11.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.23	2.11.88	0,8.07	SP33	1097.1,1098.1
B.23	4/7.11.88	2.02,2.15	SP33	1097.2,1098.2
B.23	2.11.88	0,8.07	SP34A	1099.1,1100.1
B.23	4/7.11.88	2.02,2.15	SP34A	1099.2,1100.2
B.23	2.11.88	0,8.07	SP35	1101.1,1102.1
B.23	4/7.11.88	2.02,2.15	SP35	1101.2,1102.2
B.23	2.11.88	0,8.07	SP36	1103.1,1104.1
B.23	4/7.11.88	2.02,2.15	SP36	1103.2,1104.2
B.23	2.11.88	0,8.07	SP37	1105.1,1106.1
B.23	4/7.11.88	2.02,2.15	SP37	1105.2,1106.2
B.23	2.11.88	0,8.07	SP41	1107.1,1108.1
B.23	4/7.11.88	2.02,2.15	SP41	1107.2,1108.2
B.23	2.11.88	0,8.07	SP108	1109.1,1110.1
B.23	4/7.11.88	2.02,2.15	SP108	1109.2,1110.2
B.23	2.11.88	0	RB23.B/I	1111.1,1112.1
B.23	4/7.11.88	2.02,2.15	RB23.B/I	1111.2,1112.2
B.23	2.11.88	0	RB23.B/I	1113.1,1114.1
B.23	4/7.11.88	2.02,2.15	RB23.B/I	1113.2,1114.2
B.23	2.11.88	0	RB23.B/I	1115.1,1116.1
B.23	4/7.11.88	2.02,2.15	RB23.B/I	1115.2,1116.2
B.23	2.11.88	0	RB23.B/I	1117.1,1118.1
B.23	4/7.11.88	2.02,2.15	RB23.B/I	1117.2,1118.2
B.23	2.11.88	0	RB23.B/I	1119.1,1120.1
B.23	4/7.11.88	2.02,2.15	RB23.B/I	1119.2,1120.2
B.24	10.11.88	0,2.24	SP7	1065.3,1065.4
B.24	10.11.88	0,2.24	SP9	1069.3,1069.4
B.24	10.11.88	0,2.24	SP12	1073.3,1073.4
B.24	10.11.88	0,2.24	SP14	1075.3,1075.4
B.24	10.11.88	0,2.24	SP20	1081.3,1081.4
B.24	10.11.88	0,2.24	SP31	1093.3,1093.4
B.24	10.11.88	0,2.24	SP115	895.3, 895.4
B.24	10.11.88	0,2.24	SP116	897.3, 897.4
B.24	10.11.88	0,2.24	SP117	899.3, 899.4
B.24	10.11.88	0,2.24	SP125	913.3, 913.4
B.24	10.11.88	0,2.24	SP126	915.3, 915.4
B.24	10.11.88	0,2.24	SP129	921.3, 921.4
B.24	10.11.88	0,2.24	SP141	935.3, 935.4
B.24	10.11.88	0,2.24	SP152	959.3, 959.4
B.24	10.11.88	0,2.24	SP162	973.3, 973.4
B.24	10.11.88	0,2.24	SP169	983.3, 983.4
B.24	10.11.88	0,2.24	SP173	991.3, 991.4
B.24	10.11.88	0,2.24	SP186	1013.3,1013.4
B.24	10.11.88	0,2.24	SP196	1025.3,1025.4
B.24	10.11.88	0,2.24	SP201	1033.3,1033.4
B.24	10.11.88	0,2.24	SP210	1043.3,1043.4
B.24	10.11.88	0,2.24	RB24.B	1121.1,1121.2
B.24	10.11.88	0,2.24	RB24.B	1122.1,1122.2
B.24	10.11.88	0,2.24	RB24.B	1123.1,1123.2

BATCH_INDEX Last_update:29.11.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.25	25.11.88	0,1.21	AV1A	1125.1,1126.1
B.25	25.11.88	1.73,1.99	AV1A	1125.2,1126.2
B.25	25.11.88	0,1.21	AV2A	1127.1,1128.1
B.25	25.11.88	1.73,1.99	AV2A	1127.2,1128.2
B.25	25.11.88	0,1.21	AV3A	1129.1,1130.1
B.25	25.11.88	1.73,1.99	AV3A	1129.2,1130.2
B.25	25.11.88	0,1.21	AV4A	1131.1,1132.1
B.25	25.11.88	1.73,1.99	AV4A	1131.2,1132.2
B.25	25.11.88	0,1.21	AV5A	1133.1,1134.1
B.25	25.11.88	1.73,1.99	AV5A	1133.2,1134.2
B.25	25.11.88	0,1.21	AV6A	1135.1,1136.1
B.25	25.11.88	1.73,1.99	AV6A	1135.2,1136.2
B.25	25.11.88	0,1.21	AV7A	1137.1,1138.1
B.25	25.11.88	1.73,1.99	AV7A	1137.2,1138.2
B.25	25.11.88	0,1.21	AV8A	1139.1,1140.1
B.25	25.11.88	1.73,1.99	AV8A	1139.2,1140.2
B.26	29.11.88,	0,	P1.1&2	1141
B.26	29.11.88,	0.10,	P1.3&4	1141
B.26	29.11.88,	0.20,	P1.5&6	1141
B.26	29.11.88,	0.49,	P1.7&8	1141
B.26	29.11.88,	0.98,	P1.9&10	1141
B.26	29.11.88,	1.96,	P1.11&12	1141
B.26	29.11.88,	4.90,	P1.13&14	1141
B.26	30.11.88,	9.79,	P1.15&16	1141
B.26	29.11.88,	33.29,	P1.17&18	1141
B.26	29.11.88,	0,	P2.1&2	1142
B.26	29.11.88,	0.10,	P2.3&4	1142
B.26	29.11.88,	0,	P3.1&2	1143
B.26	29.11.88,	0.10,	P3.3&4	1143
B.26	29.11.88,	0,	P4.1&2	1144
B.26	29.11.88,	0.10,	P4.3&4	1144
B.26	29.11.88,	0,	P5.1&2	1145
B.26	29.11.88,	0.10,	P5.3&4	1145
B.26	29.11.88,	0,	P6.1&2	1146
B.26	29.11.88,	0.10,	P6.3&4	1146
B.26	29.11.88,	0,	P7.1&2	1147
B.26	29.11.88,	0.10,	P7.3&4	1147

BATCH INDEX

Last update:8.12.88

Batch	Irradiation Date	Dose kGy	Sample	Runs
B.27	2.12.88	0,1.0	P8.1&2	1148
B.27	2.12.88	0.1,1.0	P8.3&4	1148
B.27	2.12.88	0.2,1.0	P8.5&6	1148
B.27	2.12.88	0.5,1.0	P8.7&8	1148
B.27	2.12.88	1.0,1.0	P8.9&10	1148
B.27	2.12.88	2.0,1.0	P8.11&12	1148
B.27	2.12.88	5.0,1.0	P8.13&14	1148
B.27	2.12.88	10.0,1.0	P8.15&16	1148
B.27	2.12.88	16.0,1.0	P8.17&18	1148
B.27	2.12.88	0,1.0	P9.1&2	1148
B.27	2.12.88	0.1,1.0	P9.3&4	1148
B.27	2.12.88	0.2,1.0	P9.5&6	1148
B.27	2.12.88	0.5,1.0	P9.7&8	1148
B.27	2.12.88	1.0,1.0	P9.9&10	1148
B.27	2.12.88	2.0,1.0	P9.11&12	1148
B.27	2.12.88	5.0,1.0	P9.13&14	1148
B.27	2.12.88	10.0,1.0	P9.15&16	1148
B.27	2.12.88	16.0,1.0	P9.17&18	1148
B.27	2.12.88	16.0,1.0	P9.19&20	1148
B.27	2.12.88	5.0	Crab shell	1151

RUN SHEET

RUN NUMBER(S): 149-256 DATE(S): 4.2.88-

TL Fading & Stability -German Samples (Batches 5&6)

(a) Procedure

The crude herbs and spices were sprinkled onto a clean stainless steel disc (10mm diam, 0.25mm thick), which had been sprayed with a thin layer of silicone grease compound, and preweighed. The discs were reweighed and the mass of sample taken was calculated in mg.

The sample discs were read on the TL reader using the "SURRC TL Package 16.3.87" disc.

The irradiated samples plus blanks were stored at 30'C for subsequent stability tests.

RUN SHEET Date(s):4.2.88-

(b)

Filename	Sample Mass/mg	Dose/ kGy	Storage Temperature	Delay/ days
SP54.T3.149.1	1.13	0	30	3.5
SP54.T3.150.1	1.12	10	30	3.5
SP55.T3.151.1	3.58	0	30	3.5
SP55.T3.152.1	2.88	10	30	3.5
SP56.T3.153.1	2.43	0	30	3.5
SP56.T3.154.1	3.19	10	30	3.5
SP57.T3.155.1	1.73	0	30	3.5
SP57.T3.156.1	1.14	10	30	3.5
SP58.T3.157.1	3.27	0	30	3.5
SP58.T3.158.1	6.39	10	30	3.5
SP59.T3.159.1	4.56	0	30	3.5
SP59.T3.160.1	4.90	10	30	3.5
SP60.T3.161.1	4.55	0	30	3.5
SP60.T3.162.1	3.06	10	30	3.5
SP61.T3.163.1	3.48	0	30	3.5
SP61.T3.164.1	5.25	10	30	3.5
SP62.T3.165.1	5.29	0	30	3.5
SP62.T3.166.1	7.60	10	30	3.5
SP63.T3.167.1	4.33	0	30	3.5
SP63.T3.168.1	3.83	10	30	3.5
SP64.T3.169.1	3.42	0	30	3.5
SP64.T3.170.1	2.47	10	30	3.5
SP65.T3.171.1	6.25	0	30	3.5
SP65.T3.172.1	7.66	10	30	3.5
SP66.T3.173.1	5.37	0	30	3.5
SP66.T3.174.1	4.67	10	30	3.5
SP67.T3.175.1	2.97	0	30	3.5
SP67.T3.176.1	3.02	10	30	3.5
SP68.T3.177.1	2.21	0	30	3.5
SP68.T3.178.1	2.16	10	30	3.5
SP69.T3.179.1	1.51	0	30	3.5
SP69.T3.180.1	1.93	10	30	3.5
SP70.T3.181.1	1.77	0	30	3.5
SP70.T3.182.1	1.71	10	30	3.5
SP71.T3.183.1	1.65	0	30	3.5
SP71.T3.184.1	1.84	10	30	3.5
SP72.T3.185.1	1.37	0	30	3.5
SP72.T3.186.1	1.52	10	30	3.5
SP73.T3.187.1	1.01	0	30	3.5
SP73.T3.188.1	1.01	10	30	3.5
SP74.T3.189.1	1.70	0	30	3.5
SP74.T3.190.1	1.64	10	30	3.5
SP75.T3.191.1	1.23	0	30	3.5
SP75.T3.192.1	1.57	10	30	3.5
SP76.T3.193.1	1.50	0	30	3.5
SP76.T3.194.1	1.42	10	30	3.5
SP77.T3.195.1	2.45	0	30	3.5
SP77.T3.196.1	0.64	10	30	3.5
SP78.T3.197.1	2.23	0	30	3.5
SP78.T3.198.1	2.01	10	30	3.5

*Filename= Sample name. Storage temp. Run. Disc

RUN SHEET

Date(s):4.2.88-

(b)

Filename*	Sample Mass/mg	Dose/ kGy	Storage Temperature	Delay/ days
SP79.T3.199.1	0.96	0	30	3.5
SP79.T3.200.1	1.09	10	30	3.5
SP80.T3.201.1	1.26	0	30	3.5
SP80.T3.202.1	1.53	10	30	3.5
SP81.T3.203.1	1.71	0	30	3.5
SP81.T3.204.1	2.17	10	30	3.5
SP82.T3.205.1	1.71	0	30	3.5
SP82.T3.206.1	2.90	10	30	3.5
SP83.T3.207.1	5.30	0	30	3.5
SP83.T3.208.1	7.92	10	30	3.5
SP84.T3.209.1	7.53	0	30	3.5
SP84.T3.210.1	7.25	10	30	3.5
SP85.T3.211.1	6.67	0	30	3.5
SP85.T3.212.1	7.64	10	30	3.5
SP86.T3.213.1	6.77	0	30	3.5
SP86.T3.214.1	7.82	10	30	3.5
SP87.T3.215.1	7.00	0	30	3.5
SP87.T3.216.1	6.42	10	30	3.5
SP88.T3.217.1	4.04	0	30	3.5
SP88.T3.218.1	3.40	10	30	3.5
SP89.T3.219.1	4.05	0	30	3.5
SP89.T3.220.1	3.60	10	30	3.5
SP90.T3.221.1	3.49	0	30	3.5
SP90.T3.222.1	4.10	10	30	3.5
SP91.T3.223.1	3.56	0	30	3.5
SP91.T3.224.1	3.76	10	30	3.5
SP92.T3.225.1	4.43	0	30	3.5
SP92.T3.226.1	4.13	10	30	3.5
SP93.T3.227.1	2.78	0	30	3.5
SP93.T3.228.1	3.02	10	30	3.5
SP94.T3.229.1	3.05	0	30	3.5
SP94.T3.230.1	3.39	10	30	3.5
SP95.T3.231.1	3.00	0	30	3.5
SP95.T3.232.1	3.19	10	30	3.5
SP96.T3.233.1	2.67	0	30	3.5
SP96.T3.234.1	3.58	10	30	3.5
SP97.T3.235.1	2.90	0	30	3.5
SP97.T3.236.1	3.74	10	30	3.5
SP98.T3.237.1	7.41	0	30	3.5
SP98.T3.238.1	6.23	10	30	3.5
SP99.T3.239.1	7.90	0	30	3.5
SP99.T3.240.1	11.36	10	30	3.5
SP100.T3.241.1	4.84	0	30	3.5
SP100.T3.242.1	5.05	10	30	3.5
SP101.T3.243.1	9.01	0	30	3.5
SP101.T3.244.1	7.81	10	30	3.5
SP102.T3.245.1	9.23	0	30	3.5
SP102.T3.246.1	5.11	10	30	3.5

*Filename= Sample name. Storage temp. Run. Disc

RUN SHEET

Date(s): 4.2.88-

(b)

Filename*	Sample Mass/mg	Dose/ kGy	Storage Temperature	Delay/ days
SP103.T3.247.1	2.09	0	30	3.5
SP103.T3.248.1	2.25	10	30	3.5
SP104.T3.249.1	3.33	0	30	3.5
SP104.T3.250.1	1.83	10	30	3.5
SP105.T3.251.1	2.88	0	30	3.5
SP105.T3.252.1	3.45	10	30	3.5
SP106.T3.253.1	3.46	0	30	3.5
SP106.T3.254.1	3.26	10	30	3.5
SP107.T3.255.1	3.79	0	30	3.5
SP107.T3.256.1	2.55	10	30	3.5
SP107.T3.256.2	3.14	10	30	6

*Filename= Sample name. Storage temp. Run. Disc

RUN SHEET Date:18.4.88

Reference	Sample Type	Specific TL @ 200'C/ cps per mg Blank	10 kGy	Our Judgement Irradiated?
SP54	TL 1	209	85900	NN
SP55	TL 2	149	27900	NN
SP56	TL 3	5100	6660	YY
SP57	TL 4	40800	108000	YY
SP58	Pfifferlinge 1	2600	2293	Y
SP59	Pfifferlinge 2	5930	9720	YY
SP60	Pfifferlinge 3	2520	285000	Y
SP61	Pfifferlinge 4	267	2900	?N
SP62	Pfifferlinge 5	4005	1380	?Y
SP63	Bohnenkraut 1	39	7640	NN
SP64	Bohnenkraut 2	9930	38200	YY
SP65	Bohnenkraut 3	2750	5820	Y
SP66	Bohnenkraut 4	4140	58600	Y
SP67	Bohnenkraut 5	5150	15500	YY
SP68	Curcuma 1	55675	44900	YY
SP69	Curcuma 2	49700	35000	YY
SP70	Curcuma 3	24400	92500	YY
SP71	Curcuma 4	11600	22300	YY
SP72	Curcuma 5	79	49500	NN
SP73	Ingwer 1	94700	20900	YY
SP74	Ingwer 2	10700	24400	YY
SP75	Ingwer 3	639	33300	N
SP76	Ingwer 4	78700	44800	YY
SP77	Ingwer 5	5710	18200	YY
SP78	Majoran 1	393	91800	NN
SP79	Majoran 2	125000	161000	YYY
SP80	Majoran 3	63500	142000	YY
SP81	Majoran 4	1430	77800	N
SP82	Majoran 5	65100	56400	YY
SP83	Paprika 1	3390	11400	YY
SP84	Paprika 2	25	4270	NN
SP85	Paprika 3	21	4350	NN
SP86	Paprika 4	22	3360	NN
SP87	Paprika 5	3960	5350	YY
SP88	Pfeffer,schwarz 1	159	6670	NN
SP89	Pfeffer,schwarz 2	227	3000	NN
SP90	Pfeffer,schwarz 3	10900	10900	YY
SP91	Pfeffer,schwarz 4	208	3190	NN
SP92	Pfeffer,schwarz 5	10300	5990	YY
SP93	Salbei 1	361	10000	NN
SP94	Salbei 2	8910	10800	YY
SP95	Salbei 3	7470	16600	YY
SP96	Salbei 4	441	14300	NN
SP97	Salbei 5	315	14400	NN
SP98	Sellerie saat 1	20600	36300	YY
SP99	Sellerie saat 2	26100	23300	YY
SP100	Sellerie saat 3	289	29900	NN
SP101	Sellerie saat 4	11300	24500	YY
SP102	Sellerie saat 5	11100	78700	YY
SP103	Thymian 1	46	10000	NN
SP104	Thymian 2	8310	23600	YY
SP105	Thymian 3	9870	107000	Y
SP106	Thymian 4	241	3780	NN
SP107	Thymian 5	297	8880	NN

RUN SHEET

Ash content of herbs and spices.

(a) Procedure

The samples were dispensed into preweighed silica combustion thimbles, which had been dried in a dessicator. The thimbles were half filled and the mass of sample taken was calculated. The samples were placed in a cold muffle furnace, and heated to 550'C for 3-4 hours, after which they were cooled in a dessicator and reweighed. The ash samples were retained for further study.

The thimbles were washed in Decon 90 in an ultrasonic bath, rinsed with tap water and then with deionised water. They were dried in an oven at 100'C, and then stored in a dessicator until required.

(b) Results Date: 4.5.88

Thimble no.	Sample no.	Mass of sample (g)	Mass of ash (g)	% ash	Specific TL 200-210 (cps per mg ash)	
					Blank	10 kGy
1	SP6	0.27632	0.01075	3.89	5300	130100
2	SP8	0.24354	0.01001	4.11	22100	1562400
3	SP10	0.29093	0.00505	1.74	59900	188800
4	SP13	0.32204	0.01240	3.85	7800	11600
5	SP21	0.29152	0.05323	18.26	1500	448700
6	SP26	0.12129	0.01599	13.18	900	27700
7	SP27	0.06598	0.00793	12.02	2700	746300
8	SP29	0.12977	0.01586	12.22	1800	128300
9	SP36	0.09312	0.01033	11.09	2700	362300
10	SP37	0.52079	0.01946	3.74	1300	8600
11	SP129	0.20871	0.01438	6.89	3300	266400
12	SP110	0.27482	0.01371	4.99	7200	66900
13	SP131	0.37004	0.00694	1.87	2100	5600
14	SP122	0.31852	0.02152	6.75	1400	2261700
15	SP157	0.37040	0.02442	6.59	2000	6235900
16	SP178	0.28883	0.03112	10.77	900	704800
17	SP137	0.07964	0.00795	9.98	1800	29200
18	SP139	0.12727	0.01125	8.85	2800	20800
20	SP144	0.26427	0.01013	3.83	3100	191100

See also tables on pages R.92 and R.93.

(c) Discussion

When plotted in histograms according to the sample group, these results did not show significantly better seperation of irradiated sample and blank than the raw data.

This is because there is a large amount of bioinorganic material present. A better estimate of mineral matter present would be obtained by determining the acid insoluble ash, rather than the total ash content of the sample.

RUN SHEET

Ash content of herbs and spices.

(b) Results

Date: 6.5.88

Thimble no.	Sample no.	Mass of sample (g)	Mass of ash (g)	% ash	Specific TL 200-210 (cps per mg ash) Blank	10 kGy
1	SP171	0.33624	0.01776	5.28	1600	439600
2	SP109	0.29434	0.01654	5.62	3200	130100
3	SP119	0.34610	0.01741	5.03	1900	203300
4	SP146	0.29801	0.01507	5.06	1900	50200
5	SP155	0.28437	0.01312	4.61	5900	192200
6	SP172	0.23514	0.01209	5.14	4800	702600
7	SP15	0.30906	0.03217	10.41	2500	287600
8	SP118	0.24552	0.02976	12.12	610	63600
9	SP128	0.30580	0.02638	8.63	1300	356300
10	SP153	0.31756	0.02827	8.90	570	153200
11	SP188	0.23814	0.02330	9.78	300	98700
12	SP108	0.37473	0.02909	7.76	1000	273800
13	SP154	0.24851	0.02518	10.13	1760	581900
14	SP189	0.31507	0.02288	7.26	370	544800
15	SP17	0.44365	0.03648	8.22	2260	220700
16	SP111	0.34220	0.03001	8.77	1030	94500
17	SP145	0.33620	0.02402	7.14	630	18900
18	SP148	0.36692	0.03575	9.74	1120	267100
19	SP191	0.26556	0.02949	11.10	560	84300
20	SP7	0.32934	0.01746	5.30	11600	61900

Date: 9.5.88

Thimble no.	Sample no.	Mass of sample (g)	Mass of ash (g)	% ash	Specific TL 200-210 (cps per mg ash) Blank	10 kGy
1	SP174	0.44798	0.02728	6.09	3300	181000
2	SP176	0.34666	0.02826	8.15	4900	33200
3	SP120	0.24983	0.01546	6.19	4500	696300
4	SP130	0.32608	0.01863	5.71	4200	447300
5	SP147B	0.24161	0.01463	6.06	2000	575000
6	SP156	0.29305	0.01594	5.44	9300	691000
7	SP20	0.31418	0.02102	6.69	1030	106300
8	SP113	0.46789	0.02848	6.09	280	32000
9	SP196	0.43991	0.03461	7.87	4300	988200
10	SP9	0.29366	0.00433	1.47	59900	188800
11	SP186	0.32462	0.01320	4.07	1520	30800
12	SP224	0.36784	0.01599	4.35	1840	71900
13	SP223	0.62348	0.02514	4.03	2950	3800
14	SP222	0.51505	0.02049	3.98	900	3500
15	SP227	0.59914	0.02794	4.66	1030	15200
16	SP180	0.42989	0.01610	3.75	850	31600
17	SP219	0.62610	0.01828	2.92	270	2600
18	SP226	0.53717	0.03642	6.78	310	620
19	SP14	0.25748	0.00293	1.14	32500	51300
20	SP147A	0.21593	0.01282	5.94	3900	1314100

RUN SHEET

Ash content of herbs and spices.

(b) Results

Date: 9.5.88 overnight

Thimble no.	Sample no.	Mass of sample (g)	Mass of ash (g)	% ash	Specific TL 200-210 (cps per mg ash) Blank	10 kGy
1	SP167	0.27521	0.02035	7.39	5300	195900
2	SP168	0.30826	0.01117	3.62	8800	84000
3	SP211	0.28388	0.03159	11.13	4900	47300
4	SP114	0.30448	0.01549	5.09	410	26100
5	SP169	0.22407	0.01221	5.45	2000	19900
6	SP213	0.32714	0.01656	5.06	510	5500
7	SP199	0.24343	0.02718	11.16	2600	1085700
8	SP214	0.34278	0.02908	8.48	350	38500
9	SP18	0.20334	0.01055	5.19	6400	60400
10	SP173	0.27038	0.01471	5.44	12400	22800
11	SP19	0.26796	0.01883	7.03	12100	97200
12	SP177	0.35085	0.02433	6.93	1100	51500
13	SP179	0.22447	0.01854	8.26	1200	170600
14	SP218	0.18599	0.01588	8.54	7600	193300
15	SP216	0.23983	0.01849	7.71	710	142600
16	SP5	0.21631	0.00955	4.41	16800	131900
17	SP210	0.36672	0.01733	4.73	8800	52000
18	SP170	0.25135	0.02118	8.43	3600	66000
19	SP212	0.10879	0.01149	10.56	115400	147200
20	SP123	0.32201	0.00418	1.30	8800	192300

Date: 10.5.88

Thimble no.	Sample no.	Mass of sample (g)	Mass of ash (g)	% ash	Specific TL 200-210 (cps per mg ash) Blank	10 kGy
1	SP112	0.33343	0.01733	5.20	3900	303900
2	SP132	0.31669	0.01826	5.77	1800	131600
3	SP192	0.30906	0.01317	4.26	1460	219700
4	SP133	0.34847	0.00403	1.16	13300	23800
5	SP194	0.39657	0.00441	1.11	6300	13400
6	SP11	0.32908	0.01195	3.63	1050	495500
7	SP12	0.27222	0.01350	4.94	12900	265800
8	SP185	0.28878	0.02009	6.96	1350	990600
9	SP22	0.27622	0.01536	5.56	3200	57300
10	SP31	0.18734	0.01186	6.33	6600	50000
11	SP117	0.21681	0.01250	5.77	4500	27900
12	SP141	0.18365	0.01040	5.66	6100	27600
13	SP163	0.26406	0.01676	6.35	35400	109000
14	SP204	0.16919	0.01161	6.86	33900	348000
15	SP34A	0.14348	0.01349	9.40	5000	262000
16	SP34B	0.10977	0.01021	9.30	3400	72000
17	SP143	0.10504	0.00869	8.27		
18	SP152	0.11697	0.01087	9.29	7200	124000
19	SP166	0.12513	0.01297	10.36	1400	196300
20	SP206	0.19670	0.02094	10.65	3300	2182200

RUN SHEET

Acid insoluble ash of herbs and spices. Date: 19.5.88

(a) Procedure

The samples were dispensed into preweighed silica crucibles (15ml), which had been dried in a dessicator. Approximately 5g of spice samples and 1-2g of herbs were taken. The samples were placed in a cold muffle furnace, and heated to 550'C for 4 hours, after which they were cooled in a dessicator and reweighed. The total ash content was calculated.

5ml 1M HCl was added to the ash and the crucibles were placed on a hotplate to simmer for 5 minutes. A reagent blank was prepared using a clean, dry, preweighed crucible and a filter paper.

The sample was filtered through a Whatman No.42 (11cm) ashless filter paper. The crucible was washed thoroughly with hot deionised water, 2x5ml portions, followed by a final wash (10ml) of the filter paper. The filter papers were placed in the original dish and ignited in the muffle, after which they were cooled in a dessicator, prior to reweighing.

The crucibles were washed in Decon 90, rinsed with tap water and then with deionised water. They were dried in an oven at 100'C, and then stored in a dessicator until required.

(b) Results

Crucible no.	Sample no.	Mass of sample (g)	Total ash %	Acid insoluble ash%	Specific TL 200-210 (cps/mg insol.ash) Blank	10 kGy
1	SP6	4.48457	3.966	0.562	36655	900356
2	SP8	4.48851	4.076	0.588	154592	10920748
3	SP10	4.45544	1.666	0.042	88095	230952
4	SP21	4.56835	18.088	0.903	29457	907364
5	SP26	2.11689	13.705	0.817	15300	447491
6	SP27	1.07775	13.136	3.045	10739	292841
7	Blank	0.04898*		0.001$		

* Mass of filter paper
$ % ash of filter paper

Acid insoluble ash of herbs and spices.

Date:24.5.88- 21.6.88

(a) Procedure

The samples were dispensed into preweighed silica crucibles , which had been dried in a dessicator. Approximately 5g of spice samples and 1-2g of herbs were taken. The samples were placed in a cold muffle furnace, and heated to 650'C for 3 hours, after which they were cooled in a dessicator and reweighed. The total ash content was calculated.

10ml 1M HCl was added to the ash and the crucibles were placed on a hotplate to simmer for 5 minutes.

The sample was filtered through a Whatman No.42 (11cm) ashless filter paper. The crucible was washed thoroughly with hot deionised water, 2x5ml portions, followed by a final wash (10ml) of the filter paper. The filter papers were placed in the original dish and ignited in the muffle overnight. The crucibles were cooled in a dessicator, and reweighed.

The crucibles were washed in Decon 90, rinsed with tap water and then with deionised water. They were dried in an oven at 100'C, and then stored in a dessicator until required.

(b) Results

Crucible no.	Sample no.	Mass of sample (g)	Total ash %	Acid insoluble ash%	Specific TL 200-210 cps/ g insol. ash Blank	10 kGy
1	SP27	0.7827	13.29	3.40	9629	262574
2	SP13	3.1970	3.81	0.21	140376	208920
3	SP129	2.6611	6.89	3.14	7291	584400
4	SP110	3.9280	4.94	0.85	42204	391559
5	SP131	5.0985	1.89	0.07	14205	72443
6	SP122	3.4192	6.84	1.75	5444	8748768
7	SP157	3.7429	6.62	1.28	10407	32155634
1	SP171	6.8451	5.83	0.97	8875	2395150
2	SP109	5.1447	5.24	0.82	22249	232763
3	SP119	5.0174	4.85	0.26	37548	3917625
4	SP146	4.1680	4.94	0.21	45023	1204739
5	SP155	4.7066	4.45	0.14	197101	6420290
6	SP172	4.7898	5.81	0.91	27483	3986203
7	SP15	3.6063	13.01$	0.93	28618	3232829
8	SP118	3.5824	6.73	0.36	20833	2140833
1	SP128	4.7848	7.11	0.58	19826	5347304
2	SP153	4.6719	6.06	0.59	8600	2298988
3	SP188	3.5405	6.61	0.42	7177	2309809
4	SP108	5.4188	4.58	0.38	20635	5620106
5	SP154	3.4931	6.60	0.48	3700	1225593
6	SP189	4.5339	6.26	0.56	4856	7113849
7	SP15	3.6063		0.19	140957	15923404
8	SP17	5.5095	7.85	0.63	29430	2870411

$ not properly ashed, residue redissolved in acid after 2nd ashing, see 7 below

RUN SHEET

Acid insoluble ash of herbs and spices.

Date:24.5.88- 21.6.88

(b) Results

Crucible no.	Sample no.	Mass of sample (g)	Total ash %	Acid insoluble asn%	Specific TL 200-210 cps/mg insol. ash Blank	10 kGy
1	SP137	0.6179	10.06	1.81	9928	160894
2	SP161	1.1656	10.59	1.78	5396	1117763
3	SP29	1.3347	7.89	1.73	12457	904037
4	SP140	0.7228	14.69	2.40	1042	168807
5	SP203	2.9415	16.99	6.67	3207	1409456
6	SP198	1.8423	3.85	0.70	84120	441059
7	SP215	0.6303	14.37	1.75	5886	1973657
8	SP217	1.5589	8.16	0.80	31698	650440
9	SP165	1.9571	9.99	0.77	138781	1105837

Samples for which the total ash had not previously been determined

Sample no.	Total Ash %	Specific TL 200-210 cps/mg ash Blank	10 kGy
SP41	3.96	5025	44495
SP23	15.97	1359	88209
SP149	14.98	1676	209419
SP124	10.41	259	14236
SP139	8.59	2922	21467
SP127	6.82	836	32507
SP35	7.39	5616	76888
SP36	10.78	2792	372727
SP30	12.36	1068	27605
SP24	3.55	85577	537775
SP136	9.01	766	3285
SP159	7.82	3069	144258
SP220	19.16	444	2748794
SP137	10.06	1789	28996
SP161	10.59	907	187771
SP29	7.89	2738	198682
SP140	14.69	170	27556
SP203	16.99	1260	553579
SP198	3.85	15273	80078
SP215	14.37	717	240355
SP217	8.16	3088	63370
SP165	9.99	10711	85345

Histograms were plotted of the Specific TL 200-210'C per mg of whole sample, total ash and acid insoluble ash, but no significant improvement in discrimination between irradiated samples and blanks was obtained.

RUN SHEET

Bleaching of the TL signal by sunlight. Date: 23.5.88

(a) Procedure

The samples irradiated in Batch 15 were spread in a thin layer in small plastic Petrie dishes, and placed, with their associated blanks, on the window sill in the laboratory immediately after irradiation.

The TL signal was measured on a logarithmic time scale beginning 3 days after irradiation.

(b) Results (3 days after irradiation) BATCH15.1

Filename	Sample mass(mg)	Dose kGy	Specific TL 200-210'C Bleached	Unbleached
SP8.T3.543.1	2.32	0	1298	909
SP8.T3.544.1	2.18	10	27606	64214
SP11.T3.545.1	2.43	0	286	38
SP11.T3.546.1	3.17	10	759	17985
SP15.T3.547.1	4.78	0	106	265
SP15.T3.548.1	4.88	10	10293	29936
SP20.T3.549.1	2.22	0	13	69
SP20.T3.550.1	2.51	10	6979	7110
SP23.T3.551.1	3.52	0	288	217
SP23.T3.552.1	5.37	10	13076	14087
SP34A.T3.553.1	4.55	0	339	474
SP34A.T3.554.1	3.43	10	7438	24629
SP35.T3.555.1	2.38	0	427	415
SP35.T3.556.1	5.08	10	2362	5682
SP36.T3.557.1	2.11	0	284	301
SP36.T3.558.1	3.24	10	20345	40180
SP41.T3.559.1	6.10	0	146	199
SP41.T3.560.1	4.61	10	228	3315
SP16.T3.561.1	10.53	0	29	30
SP16.T3.562.1	9.69	10	590	5218
SP45.T3.563.1	12.49	0	102	37
SP45.T3.564.1	11.87	10	8364	303242
SP40B.T3.565.1	9.05	0	209	45
SP40B.T3.566.1	10.29	10	11640	569154

RUN SHEET

Bleaching of the TL signal by sunlight. Date: 30.5.88

(b) Results (7 days after irradiation) BATCH15.2

Filename	Sample mass(mg)	Dose kGy	Specific TL 200-210'C Bleached	Unbleached
SP8.T3.543.2	4.20	0	2051	883
SP8.T3.544.2	3.55	10	6407	112889
SP11.T3.545.2	3.26	0	425	100
SP11.T3.546.2	2.93	10	683	446?
SP15.T3.547.2	5.33	0	140	334
SP15.T3.548.2	6.32	10	9558	52336
SP20.T3.549.2	5.12	0	25	-
SP20.T3.550.2	3.72	10	5811	4225
SP23.T3.551.2	3.44	0	293	608
SP23.T3.552.2	5.96	10	5007	8497
SP34A.T3.553.2	5.06	0	363	741
SP34A.T3.554.2	5.30	10	6901	16737
SP35.T3.555.2	3.77	0	359	594
SP35.T3.556.2	4.37	10	1988	9993
SP36.T3.557.2	4.42	0	265	402
SP36.T3.558.2	4.25	10	7111	58107
SP41.T3.559.2	5.34	0	1041?	135
SP41.T3.560.2	5.26	10	181	584
SP16.T3.561.2	6.87	0	87	29
SP16.T3.562.2	5.41	10	446	4138
SP45.T3.563.2	15.58	0	189	50
SP45.T3.564.2	16.17	10	1065	294931
SP40B.T3.565.2	11.88	0	65	-
SP40B.T3.566.2	13.37	10	1970	727625

RUN SHEET

Bleaching of the TL signal by sunlight. Date: 6.6.88

(b) Results (14 days after irradiation) BATCH15.3

Filename	Sample mass(mg)	Dose kGy	Specific TL 200-210'C Bleached	Unbleached
SP8.T3.543.3	4.07	0	2554	776
SP8.T3.544.3	3.85	10	4686	39164
SP11.T3.545.3	2.75	0	444	133
SP11.T3.546.3	2.83	10	860	3935
SP15.T3.547.3	4.45	0	204	350
SP15.T3.548.3	5.25	10	4754	33786
SP20.T3.549.3	3.83	0	299	14
SP20.T3.550.3	3.64	10	2059	128070
SP23.T3.551.3	3.88	0	469	675
SP23.T3.552.3	3.10	10	2511	4484
SP34A.T3.553.3	2.96	0	637	177
SP34A.T3.554.3	2.56	10	6020	682?
SP35.T3.555.3	5.02	0	621	255
SP35.T3.556.3	3.14	10	1204	1203?
SP36.T3.557.3	3.90	0	411	451
SP36.T3.558.3	3.83	10	1524	5522?
SP41.T3.559.3	2.22	0	79	36
SP41.T3.560.3	2.82	10	100	38?
SP16.T3.561.3	8.11	0	220	-
SP16.T3.562.3	7.12	10	1438	3474?
SP45.T3.563.3	8.59	0	357	-
SP45.T3.564.3	7.20	10	4957	101516?
SP40B.T3.565.3	6.88	0	32	41
SP40B.T3.566.3	10.73	10	713	167351?

Bleaching of the TL signal by sunlight. Date: 20.6.88

(b) Results (28 days after irradiation) BATCH15.4

Filename	Sample mass(mg)	Dose kGy	Specific TL 200-210'C Bleached	Unbleached
SP8.T3.543.4	2.75	0	2321	762
SP8.T3.544.4	2.57	10	7045	42103
SP11.T3.545.4	3.36	0	583	116
SP11.T3.546.4	3.14	10	786	18805
SP15.T3.547.4	4.91	0	271	110
SP15.T3.548.4	3.77	10	3460	31966
SP20.T3.549.4	2.85	0	141	3
SP20.T3.550.4	3.05	10	6459	8516
SP23.T3.551.4	3.81	0	480	243
SP23.T3.552.4	5.45	10	1077	5563
SP34A.T3.553.4	4.19	0	780	436
SP34A.T3.554.4	5.69	10	2391	6791
SP35.T3.555.4	5.82	0	821	374
SP35.T3.556.4	1.31	10	2445	5826
SP36.T3.557.4	4.52	0	694	726
SP36.T3.558.4	3.44	10	1953	27625
SP41.T3.559.4	7.38	0	85	-
SP41.T3.560.4	7.27	10	86	253
SP16.T3.561.4	10.12	0	162	46
SP16.T3.562.4	9.88	10	1134	7555
SP45.T3.563.4	11.94	0	1012	17
SP45.T3.564.4	11.52	10	4675	245969
SP40B.T3.565.4	11.69	0	18	-
SP40B.T3.566.4	16.59	10	2945	556183

RUN SHEET

Bleaching of the TL signal by sunlight. Date: 19.7.88

(b) Results (57 days after irradiation)

Filename	Sample mass(mg)	Dose kGy	Specific TL 200-210'C Bleached	Unbleached
SP8.T3.543.5	2.44	0	2326	2236?
SP8.T3.544.5	2.06	10	2612	25127
SP11.T3.545.5	1.97	0	880	50
SP11.T3.546.5	2.68	10	534	1465
SP15.T3.547.5	4.75	0	472	151
SP15.T3.548.5	4.57	10	2169	9500
SP20.T3.549.5	3.13	0	161	36
SP20.T3.550.5	2.91	10	1373	1388
SP23.T3.551.5	1.41	0	518	239
SP23.T3.552.5	3.87	10	940	4349
SP34A.T3.553.5	4.36	0	574	338
SP34A.T3.554.5	4.04	10	662	5726
SP35.T3.555.5	4.97	0	720	744
SP35.T3.556.5	3.77	10	1231	3813
SP36.T3.557.5	2.76	0	781	351
SP36.T3.558.5	1.07	10	5023	8041
SP41.T3.559.5	2.05	0	27	74
SP41.T3.560.5	1.17	10	33	92
SP16.T3.561.5	9.54	0	154	26
SP16.T3.562.5	7.82	10	521	5230
SP45.T3.563.5	9.76	0	1747	11
SP45.T3.564.5	15.80	10	3070	205280
SP40B.T3.565.5	18.85	0	43	46
SP40B.T3.566.5	18.26	10	578	423000

RUN SHEET

Bleaching of the TL signal by sunlight. Date: 13.9.88-

(b) Results (113 days after irradiation)

Filename	Sample mass(mg)	Dose kGy	Specific TL 200-210'C Bleached	Unbleached
SP8.T3.543.6	2.41	0	3720	673
SP8.T3.544.6	1.89	10	5897	7584
SP11.T3.545.6	1.66	0	1130	136
SP11.T3.546.6	1.97	10	1129	2896
SP15.T3.547.6	3.65	0	1421	82
SP15.T3.548.6	3.62	10	3093	10138
SP20.T3.549.6	2.99	0	177	7
SP20.T3.550.6	1.95	10	10085	600
SP23.T3.551.6	2.23	0	461	213
SP23.T3.552.6	4.77	10	670	2379
SP34A.T3.553.6	2.36	0	805	647
SP34A.T3.554.6	2.11	10	1410	3854
SP35.T3.555.6	6.76	0	160	719
SP35.T3.556.6	1.77	10	2596	7177
SP36.T3.557.6	2.75	0	978	793
SP36.T3.558.6	2.27	10	2160	8739
SP41.T3.559.6	3.19	0	70	64
SP41.T3.560.6	3.33	10	62	104
SP16.T3.561.6	6.55	0	506	29
SP16.T3.562.6	6.47	10	441	2370
SP45.T3.563.6	8.79	0	2122	15
SP45.T3.564.6	10.55	10	3234	233460
SP40B.T3.565.6	12.41	0	46	89
SP40B.T3.566.6	16.51	10	1417	428683

RUN SHEET

Bleaching of the TL signal by sunlight. Date: 9.1.89

(b) Results (232 days after irradiation)

Filename	Sample mass(mg)	Dose kGy	Specific TL 200-210'C Bleached	Unbleached
SP8.T3.543.7	2.25	0	3420	265
SP8.T3.544.7	1.93	10	4064	1173
SP11.T3.545.7	2.12	0	742	30
SP11.T3.546.7	2.79	10	1472	135
SP15.T3.547.7	5.23	0	1512	45
SP15.T3.548.7	3.60	10	2519	9278
SP20.T3.549.7	2.76	0	113	0
SP20.T3.550.7	2.98	10	2186	514
SP23.T3.551.7	3.22	0	485	44
SP23.T3.552.7	5.12	10	731	558
SP34A.T3.553.7	4.78	0	764	116
SP34A.T3.554.7	6.92	10	1203	118
SP35.T3.555.7	5.15	0	824	88
SP35.T3.556.7	5.92	10	773	428
SP36.T3.557.7	2.94	0	1015	140
SP36.T3.558.7	2.61	10	1688	1231
SP41.T3.559.7	2.88	0	173	26
SP41.T3.560.7	6.26	10	85	41
SP16.T3.561.7	8.70	0	601	1
SP16.T3.562.7	8.10	10	474	144
SP45.T3.563.7	11.45	0	980	3
SP45.T3.564.7	12.99	10	2926	104809
SP40B.T3.565.7	21.28	0	90	10
SP40B.T3.566.7	25.24	10	1719	102754

RUN SHEET

RUN NUMBER(S): 511-542 DATE(S): 25.5.88-26.5.88

Density separation of Batch 15 herbs and spices.

(a)Procedure

(i) The sample was placed in a clean centrifuge tube to a depth of 0.5cm. A 5cm level was marked on the outside of the tube.
(ii) Sodium polytungstate (1.702g/cc) was added to the marked level and the sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s at speed 1 (500g)
(iv) The upper layer was decanted through a filter into a clean centrifuge tube. The sides of the sample tube were cleaned using a small tissue. The undiluted density fluid was placed back in the bottle.
(v) The mineral fraction was washed with deionised water and centrifuged twice, pouring the liquid phase through the same filter as before. The diluted density fluid was retained for reconcentration.
(vi) The mineral phase was washed in 1M.HCl to a depth of 1cm for 30 minutes. The acid was neutralised by the addition of ammonia , diluted to the mark and centrifuged for 30s. The liquid phase was discarded, and the residue was washed in deionised water and centrifuged twice.
(vii)The mineral phase was washed in acetone and allowed to stand for 5 minutes, twice.
(viii) A clean preweighed disc was placed in a flat bottomed settling tube. The mineral phase suspended in the acetone was transfered to the settling tube. The tube was placed in an oven at 55'C overnight to drive off the acetone.
(ix) Meanwhile, the filter papers were washed twice with water and twice with acetone and allowed to dry in the oven. The residue from the filter papers was dispensed onto clean stainless steel discs, sprayed with silicone grease.
(x) The discs were read on the TL reader using the "System 2.3 /22.2.88" system disc.

Notes

(a) Incomplete separation of the mineral phase and the organic residue was achieved for SP20 Turmeric.
(b) SP15 Cayenne and SP41 Onion formed a gelatious mass when hydrated resulting in a very slow filtration rate.

RUN SHEET

RUN NUMBER(S): 511-542 DATE(S): 25.5.88-26.5.88

Density separation of Batch 15 herbs and spices.

(b)Results BATCH15/DEN.SEP1

Filename	Phase	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP8.T3.511.1	Residue	0	1.39	301
SP8.T3.512.1	Mineral	0	0.96	1045
SP8.T3.513.1	Residue	10	1.90	8202
SP8.T3.514.1	Mineral	10	0.55	1357325
SP15.T3.515.1	Residue	0	5.98	240
SP15.T3.516.1	Mineral	0	0.12	1221
SP15.T3.517.1	Residue	10	7.51	1376
SP15.T3.518.1	Mineral	10	0.19	4170024
SP20.T3.519.1	Residue	0	3.39	647
SP20.T3.520.1	Mineral	0	2.20*	67
SP20.T3.521.1	Residue	10	3.50	12985
SP20.T3.522.1	Mineral	10	2.06*	19913
SP23.T3.523.1	Residue	0	4.73	174
SP23.T3.524.1	Mineral	0	0.01	6000
SP23.T3.525.1	Residue	10	5.99	2868
SP23.T3.526.1	Mineral	10	0.04	1770063
SP34A.T3.527.1	Residue	0	5.18	327
SP34A.T3.528.1	Mineral	0	0.01n	85650
SP34A.T3.529.1	Residue	10	3.79	2292
SP34A.T3.530.1	Mineral	10	0.06	105183
SP35.T3.531.1	Residue	0	5.12	160
SP35.T3.532.1	Mineral	0	0.05	0
SP35.T3.533.1	Residue	10	2.29	628
SP35.T3.534.1	Mineral	10	0.01n	155300
SP36.T3.535.1	Residue	0	1.19	415
SP36.T3.536.1	Mineral	0	0.01	0
SP36.T3.537.1	Residue	10	3.25	1536
SP36.T3.538.1	Mineral	10	0.24	3013013
SP41.T3.539.1	Residue	0	1.21	1786$
SP41.T3.540.1	Mineral	0	0.01n	0
SP41.T3.541.1	Residue	10	3.70	521
SP41.T3.542.1	Mineral	10	0.01	78850

* The mineral phase was not completely separated from the organic residue. It was in the form of a cake of material which was dislodged when the disc was removed from the settling tube, therefore the disc was sprayed with silicone grease, weighed and the sample redispensed.

n Nominal weight entered because the sample weight was too small to measure on a five figure balance.

$ Contaminated blank.

RUN SHEET

RUN NUMBER(S): 567-630 DATE(S): 31.5.88

Density separation of Batch 16 herbs and spices.

(a) Procedure

(i) The sample was placed in a clean centrifuge tube to a depth of 0.5cm. A 5cm level was marked on the outside of the tube.
(ii) Sodium polytungstate (1.702g/cc) was added to the marked level and the sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s at speed 1 (500g)
(iv) The upper layer was decanted through a filter into a clean centrifuge tube. The sides of the sample tube were cleaned using a small tissue. The undiluted density fluid was placed back in the bottle.
(v) The mineral fraction was washed with deionised water and centrifuged twice, pouring the liquid phase through the same filter as before. The diluted density fluid was retained for reconcentration.
(vi) The mineral phase was washed in 1M.HCl to a depth of 1cm for 30 minutes. The acid was neutralised by the addition of ammonia , diluted to the mark and centrifuged for 30s. The liquid phase was discarded, and the residue was washed in deionised water and centrifuged twice.
(vii) The mineral phase was washed in acetone and allowed to stand for 5 minutes, twice. The excess acetone was removed using a disposable Pasteur pipette.
(viii) A clean preweighed disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone, was transfered to the settling tube. The tube was placed in an oven at 55'C overnight to drive off the acetone.
(ix) Meanwhile, the filter papers were washed twice with water and twice with acetone and allowed to dry in the oven. The residue from the filter papers was dispensed onto clean stainless steel discs, sprayed with silicone grease.
(x) The discs were read on the TL reader using the "System 2.3 /22.2.88" system disc.

Notes

(a) Incomplete separation of the mineral phase and the organic residue was achieved for SP9 Mace.
(b) SP129 Cinnnamon, SP120 Ginger, SP7 Cloves, SP9 Mace, and SP37 Garlic had a very slow filtration rate.

RUN SHEET

RUN NUMBER(S): 567-630 DATE(S): 31.5.88

Density separation of Batch 16 herbs and spices.

(b)Results BATCH16DEN.SEP

Filename	Phase	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP226.T3.567.1	Residue	0	18.77	23
SP226.T3.568.1	Mineral	0	0.01	0
SP226.T3.569.1	Residue	10	19.46	43
SP226.T3.570.1	Mineral	10	0.01n	1545
SP10.T3.571.1	Residue	0	5.90	12
SP10.T3.572.1	Mineral	0	0.13	61
SP10.T3.573.1	Residue	10	7.18	21
SP10.T3.574.1	Mineral	10	0.23	130
SP37.T3.575.1	Residue	0	2.79	20
SP37.T3.576.1	Mineral	0	0.01n	0
SP37.T3.577.1	Residue	10	2.18	993
SP37.T3.578.1	Mineral	10	0.01n	169500
SP227.T3.579.1	Residue	0	4.73	21
SP227.T3.580.1	Mineral	0	0.01	0
SP227.T3.581.1	Residue	10	15.20	52
SP227.T3.582.1	Mineral	10	0.01n	1089700
SP124.T3.583.1	Residue	0	3.58	69
SP124.T3.584.1	Mineral	0	0.01n	200
SP124.T3.585.1	Residue	10	4.54	1768
SP124.T3.586.1	Mineral	10	0.03	1297100
SP127.T3.587.1	Residue	0	2.01	383
SP127.T3.588.1	Mineral	0	0.01n	0
SP127.T3.589.1	Residue	10	3.75	496
SP127.T3.590.1	Mineral	10	0.01n	417900
SP7.T3.591.1	Residue	0	1.90	1248
SP7.T3.592.1	Mineral	0	0.29	224
SP7.T3.593.1	Residue	10	4.00	697
SP7.T3.594.1	Mineral	10	0.39	87126
SP9.T3.595.1	Residue	0	4.16	121
SP9.T3.596.1	Mineral	0	0.02	0
SP9.T3.597.1	Residue	10	5.26	262
SP9.T3.598.1	Mineral	10	0.01n*	0*

* The mineral phase was not completely separated from the organic residue. It was in the form of a cake of material which was dislodged when the disc was removed from the settling tube. A nominal weight was entered but apparently there was no material on the disc.

n Nominal weight entered because the sample weight was too small to measure on a five figure balance.

RUN SHEET

RUN NUMBER(S): 567-630 DATE(S): 31.5.88

Density separation of Batch 16 herbs and spices.

(b)Results BATCH16DEN.SEP

Filename	Phase	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP139.T3.599.1	Residue	0	2.21	276
SP139.T3.600.1	Mineral	0	0.01n	550
SP139.T3.601.1	Residue	10	2.09	1084
SP139.T3.602.1	Mineral	10	0.01n	5554250
SP31.T3.603.1	Residue	0	10.48	542
SP31.T3.604.1	Mineral	0	0.02	0
SP31.T3.605.1	Residue	10	5.20	115$
SP31.T3.606.1	Mineral	10	0.01	311300
SP163.T3.607.1	Residue	0	4.03	1163
SP163.T3.608.1	Mineral	0	0.01n	500
SP163.T3.609.1	Residue	10	2.01	2319
SP163.T3.610.1	Mineral	10	0.01n	5687450
SP118.T3.611.1	Residue	0	2.35	113
SP118.T3.612.1	Mineral	0	0.01n	1150
SP118.T3.613.1	Residue	10	2.94	3357
SP118.T3.614.1	Mineral	10	0.30	1821293
SP149.T3.615.1	Residue	0	2.81	171
SP149.T3.616.1	Mineral	0	0.01n	250
SP149.T3.617.1	Residue	10	3.66	1934
SP149.T3.618.1	Mineral	10	0.01n	4875200
SP129.T3.619.1	Residue	0	1.70	383
SP129.T3.620.1	Mineral	0	2.13	269
SP129.T3.621.1	Residue	10	1.42	2863
SP129.T3.622.1	Mineral	10	0.44	2144464
SP120.T3.623.1	Residue	0	2.09	211
SP120.T3.624.1	Mineral	0	0.01n	42100
SP120.T3.625.1	Residue	10	3.72	8089
SP120.T3.626.1	Mineral	10	1.38	2172792
SP27.T3.627.1	Residue	0	2.11	554
SP27.T3.628.1	Mineral	0	0.01n	14500
SP27.T3.629.1	Residue	10	1.59	12737
SP27.T3.630.1	Mineral	10	0.01n	67212000

n Nominal weight entered because the sample weight was too small to measure on a five figure balance.

$ Sample may have blown off disc. No sample on disc at end of run.

RUN SHEET

RUN NUMBER(S): DATE(S):

Density separation of Batch herbs and spices.

Laboratory Work Sheet Completed by:

PROCEDURE CHECK LIST 10kGy Blank

1. Label 8 tubes & mark 5cm level
2. Put samples into tubes (0.5cm)
3. Add density liquid to mark
4. Agitate to wet sample
5. Shake in ultrasonic bath 2 minutes
6. Fold filter papers and place in 2nd row of 8 tubes
7. Centrifuge 30 seconds
8. Decant upper layer into filters
9. Wipe inside of tubes with tissue
10. Fill to level with deionised water, centrifuge 30s, add to filter, twice
11. Add 1cm 1M HCl and leave 30 minutes
12. Start 2nd batch of 8 samples and repeat steps 1-11
13. Also wash filter papers once more with deionised water and once with acetone
14. Dry filter papers on another paper, label and place in oven to dry
15. After 30 min in HCl, neutralise with ammonia and fill to mark, allow to settle 5 min
16. Discard upper layer, rinse with deionised water and centrifuge 30s, twice
17. Fill to mark with acetone, settle 5 min, pipette off excess acetone
18. Add 1-2cm acetone, agitate & transfer to labelled settling tube
19. Place tubes in oven to dry overnight
20. Clean centrifuge tubes with Decon in ultrasonic bath, rinse with tap water and then with deionised water. Keep tubes used for Blanks separate from those of 10kGy to reduce risk of cross contamination.

RUN SHEET

RUN NUMBER(S): 663-678 & 759-774 DATE(S): 8.6.88

Density separation of Batch 17.3 herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a clean centrifuge tube to a depth of 0.5cm. A 5cm level was marked on the outside of the tube.
(ii) Sodium polytungstate (1.70 g/cc) was added to the marked level and the sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s at speed 1 (500g)
(iv) The upper layer was decanted through a filter into a clean centrifuge tube. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for filtration and reconcentration.
(v) The mineral fraction was washed with deionised water and centrifuged twice, pouring the liquid phase through the same filter as before. The diluted density fluid was retained for reconcentration.
(vi) The mineral phase was washed in 1M.HCl to a depth of 1cm for 30 minutes. The acid was neutralised by the addition of ammonia , diluted to the mark and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and centrifuged twice.
(vii)The mineral phase was washed in acetone and allowed to stand for 5 minutes. The excess acetone was removed using a disposable Pasteur pipette.
(viii) A clean preweighed disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone, was transfered to the settling tube. The tube was placed in an oven at 55'C overnight to drive off the acetone.
(ix) Meanwhile, the filter papers were washed once with water and once with acetone and allowed to dry in the oven. The residue from the filter papers was dispensed onto clean stainless steel discs, sprayed with silicone grease. Excess residue was retained.
(x) The discs were read on the TL reader using the "System 2.3 /22.2.88" system disc. The mineral sample discs were retained for reirradiation.

Notes
Separation of the mineral phase and the organic phase was incomplete for SP157 Turmeric.

RUN SHEET

RUN NUMBER(S): 663-678 Mineral Phase DATE(S): 8.6.88
759-774 Organic Residue

Density separation of Batch 17.3 herbs and spices by CS.

(b)Results

Summary file name = BATCH17.MIN

Filename	Bottle no.	Mass of disc (g)	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP148.T3.663.1	33	0.17356	10	0.01n	34112750
SP148.T3.664.1	41	0.17210	0	0.01n	186800
SP191.T3.665.1	34	0.16999	10	0.01n	39402350
SP191.T3.666.1	42	0.17251	0	0.01n	49300
SP174.T3.667.1	35	0.16890	10	0.01n	3752700
SP174.T3.668.1	43	0.17067	0	0.01n	4800
SP176.T3.669.1	36	0.17051	10	0.01n	11189250
SP176.T3.670.1	44	0.17093	0	0.01n	52450
SP11 T3.671.1	37	0.17267	10	0.01n	2120550
SP11.T3.672.1	45	0.16844	0	0.01n	6050
SP110.T3.673.1	38	0.17024	10	0.01n	23191250
SP110.T3.674.1	46	0.17459	0	0.01n	191250
SP157.T3.675.1	39	0.17338	10	0.01n	43980700
SP157.T3.676.1	47	0.17006	0	0.01n	36350
SP131.T3.677.1	40	0.17385	10	0.01n	15150
SP131.T3.678.1	48	0.17162	0	0.01n	10850

n = nominal weight

Summary file name = BATCH17.RES

Filename	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP148.T3.759.1	10	1.06	2602
SP148.T3.760.1	0	1.95	588
SP191.T3.761.1	10	3.72	7417
SP191.T3.762.1	0	1.85	2380
SP174.T3.763.1	10	3.07	814
SP174.T3.764.1	0	3.73	242
SP176.T3.765.1	10	3.15	567
SP176.T3.766.1	0	3.39	394
SP11.T3.767.1	10	3.31	91
SP11.T3.768.1	0	2.34	78
SP110.T3.769.1	10	0.89	820
SP110.T3.770.1	0	1.77	165
SP157.T3.771.1	10	2.88	5978
SP157.T3.772.1	0	2.50	62
SP131.T3.773.1	10	2.19	135
SP131.T3.774.1	0	5.31	20

RUN SHEET

RUN NUMBER(S): 679-694 & 775-790 DATE(S): 8.6.88

Density separation of Batch 17.4 herbs and spices by KC.

(a) Procedure

(i) The sample was placed in a clean centrifuge tube to a depth of 0.5cm. A 5cm level was marked on the outside of the tube.
(ii) Sodium polytungstate (1.70 g/cc) was added to the marked level and the sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s at speed 1 (500g)
(iv) The upper layer was decanted through a filter into a clean centrifuge tube. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for filtration and reconcentration.
(v) The mineral fraction was washed with deionised water and centrifuged twice, pouring the liquid phase through the same filter as before. The diluted density fluid was retained for reconcentration.
(vi) The mineral phase was washed in 1M.HCl to a depth of 1cm for 30 minutes. The acid was neutralised by the addition of ammonia , diluted to the mark and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and centrifuged twice.
(vii) The mineral phase was washed in acetone and allowed to stand for 5 minutes. The excess acetone was removed using a disposable Pasteur pipette.
(viii) A clean preweighed disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone, was transfered to the settling tube. The tube was placed in an oven at 55'C overnight to drive off the acetone.
(ix) Meanwhile, the filter papers were washed once with water and once with acetone and allowed to dry in the oven. The residue from the filter papers was dispensed onto clean stainless steel discs, sprayed with silicone grease. Excess residue was retained.
(x) The discs were read on the TL reader using the "System 2.3 /22.2.88" system disc. The mineral sample discs were retained for reirradiation.

RUN SHEET

RUN NUMBER(S): 679-694 Mineral Phase DATE(S): 8.6.88
775-790 Organic Residue

Density separation of Batch 17.4 herbs and spices by KC.

(b)Results

Summary file name = BATCH17.MIN

Filename	Bottle no.	Mass of disc (g)	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP13 T3.679.1	49	0.17189	10	0.01n	190800
SP13.T3.680.1	57	0.17214	0	0.01n	4900
SP122.T3.681.1	50	0.17071	10	0.01n	24125550
SP122.T3.682.1	58	0.17097	0	0.01n	23050
SP26 T3.683.1	51	0.17026	10	0.01n	717900
SP26.T3.684.1	59	0.17080	0	0.01n	3050
SP167.T3.685.1	52	0.17192	10	0.01n	7854100
SP167.T3.686.1	60	0.17020	0	0.01n	19800
SP114.T3.687.1	53	0.17002	10	0.01n	347250
SP114.T3.688.1	61	0.17274	0	0.01n	2900
SP214.T3.689.1	54	0.17194	10	0.01n	24306750
SP214.T3.690.1	62	0.17256	0	0.01n	14900
SP18 T3.691.1	55	0.17081	10	0.01n	337800
SP18.T3.692.1	63	0.17092	0	0.01n	1850
SP19 T3.693.1	56	0.17151	10	0.01n	1946050
SP19.T3.694.1	64	0.17231	0	0.01n	4350

n = nominal weight

Summary file name = BATCH17.RES

Filename	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP13.T3.775.1	10	2.74	155
SP13.T3.776.1	0	2.71	151
SP122.T3.777.1	10	2.25	1881
SP122.T3.778.1	0	4.74	108
SP26.T3.779.1	10	3.05	304
SP26.T3.780.1	0	1.16	24
SP167.T3.781.1	10	1.49	1090
SP167.T3.782.1	0	3.56	205
SP114.T3.783.1	10	18.94	26
SP114.T3.784.1	0	21.53	18
SP214.T3.785.1	10	5.82	615
SP214.T3.786.1	0	4.65	82
SP18.T3.787.1	10	2.64	364
SP18.T3.788.1	0	1.58	448
SP19.T3.789.1	10	0.21 *	491
SP19.T3.790.1	0	0.01n*	1600

n = nominal weight
* not much residue on filter paper

RUN SHEET

RUN NUMBER(S): 695-710 & 791-806 DATE(S): 8.6.88

Density separation of Batch 17.5 herbs and spices by DCWS.

(a)Procedure

(i) The sample was placed in a clean centrifuge tube to a depth of 0.5cm. A 5cm level was marked on the outside of the tube.
(ii) Sodium polytungstate (1.70 g/cc) was added to the marked level and the sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s at speed 1 (500g)
(iv) The upper layer was decanted through a filter into a clean centrifuge tube. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for filtration and reconcentration.
(v) The mineral fraction was washed with deionised water and centrifuged twice, pouring the liquid phase through the same filter as before. The diluted density fluid was retained for reconcentration.
(vi) The mineral phase was washed in 1M.HCl to a depth of 1cm for 30 minutes. The acid was neutralised by the addition of ammonia , diluted to the mark and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and centrifuged twice.
(vii)The mineral phase was washed in acetone and allowed to stand for 5 minutes. The excess acetone was removed using a disposable Pasteur pipette.
(viii) A clean preweighed disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone, was transfered to the settling tube. The tube was placed in an oven at 55'C overnight to drive off the acetone.
(ix) Meanwhile, the filter papers were washed once with water and once with acetone and allowed to dry in the oven. The residue from the filter papers was dispensed onto clean stainless steel discs, sprayed with silicone grease. Excess residue was retained.
(x) The discs were read on the TL reader using the "System 2.3 /22.2.88" system disc. The mineral sample discs were retained for reirradiation.

Note
The sodium polytungstate was filtered before adding to the blank samples as a piece of leafy material was found in it. This could have been a source of cross contamination.

RUN SHEET

RUN NUMBER(S): 695-710 Mineral Phase DATE(S): 8.6.88
791-806 Organic Residue

Density separation of Batch 17.5 herbs and spices by DCWS.

(b)Results

Summary file name = BATCH17.MIN

Filename	Bottle no.	Mass of disc (g)	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP216.T3.695.1	65	0.16940	10	0.01n	272100
SP216.T3.696.1	74	0.17087	0	0.01n	10200
SP30 T3.697.1	66	0.16980	10	0.01n	19400
SP30.T3.698.1	75	0.17010	0	0.01n	500
SP34B.T3.699.1	67	0.17178	10	0.01n	260500
SP34B.T3.700.1	76	0.17057	0	0.01n	200
SP24 T3.701.1	68	0.17169	10	0.01n	11235450
SP24.T3.702.1	77	0.16993	0	0.01n	9150
SP136.T3.703.1	53	0.16892	10	0.01n	327850
SP136.T3.704.1	78	0.17120	0	0.01n	500
SP159.T3.705.1	70	0.17068	10	0.01n	1336500
SP159.T3.706.1	79	0.16893	0	0.01n	3150
SP220.T3.707.1	71	0.17133	10	0.01n	143511800
SP220.T3.708.1	80	0.17070	0	0.01n	110000
SP165.T3.709.1	72	0.17033	10	0.01n	1532550
SP165.T3.710.1	81	0.17186	0	0.01n	0

n = nominal weight

Summary file name = BATCH17.RES

Filename	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP216.T3.791.1	10	16.41	83
SP216.T3.792.1	0	15.04	5
SP30.T3.793.1	10	1.35	100
SP30.T3.794.1	0	4.46	48
SP34B.T3.795.1	10	2.63	2476
SP34B.T3.796.1	0	0.94	281
SP24.T3.797.1	10	1.60	1417
SP24.T3.798.1	0	1.63	824
SP136.T3.799.1	10	2.73	329
SP136.T3.800.1	0	2.36	20
SP159.T3.801.1	10	1.67	32878
SP159.T3.802.1	0	2.80	45
SP220.T3.803.1	10	2.35	5876
SP220.T3.804.1	0	2.79	214
SP165.T3.805.1	10	1.35	5724
SP165.T3.806.1	0	6.09	143

RUN SHEET

RUN NUMBER(S): 711-726 & 807-822 DATE(S): 9.6.88

Density separation of Batch 17.6 herbs and spices by CS.

(a)Procedure

(i) The sample was placed in a clean centrifuge tube to a depth of 0.5cm. A 5cm level was marked on the outside of the tube.
(ii) Sodium polytungstate (1.70 g/cc) was added to the marked level and the sample was aggitated to break up and disperse the spice.
(iii) The tubes were shaken in the ultrasonic bath for two minutes and centrifuged for 30s at speed 1 (500g)
(iv) The upper layer was decanted through a filter into a clean centrifuge tube. The sides of the sample tube were cleaned using a small tissue. The density fluid was retained for filtration and reconcentration.
(v) The mineral fraction was washed with deionised water and centrifuged twice, pouring the liquid phase through the same filter as before. The diluted density fluid was retained for reconcentration.
(vi) The mineral phase was washed in 1M.HCl to a depth of 1cm for 30 minutes. The acid was neutralised by the addition of ammonia , diluted to the mark and allowed to stand for 5 minutes. The liquid phase was discarded, and the residue was washed in deionised water and centrifuged twice.
(vii)The mineral phase was washed in acetone and allowed to stand for 5 minutes. The excess acetone was removed using a disposable Pasteur pipette.
(viii) A clean preweighed disc was placed in a flat bottomed settling tube. The mineral phase, suspended in the acetone, was transfered to the settling tube. The tube was placed in an oven at 55'C overnight to drive off the acetone.
(ix) Meanwhile, the filter papers were washed once with water and once with acetone and allowed to dry in the oven. The residue from the filter papers was dispensed onto clean stainless steel discs, sprayed with silicone grease. Excess residue was retained.
(x) The discs were read on the TL reader using the "System 2.3 /22.2.88" system disc. The mineral sample discs were retained for reirradiation.

RUN SHEET

RUN NUMBER(S): 711-726 Mineral Phase DATE(S): 9.6.88
807-822 Organic Residue

Density separation of Batch 17.6 herbs and spices by CS.

(b)Results

Summary file name = BATCH17.MIN

Filename	Bottle no.	Mass of disc (g)	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP217.T3.711.1	82	0.17299	10	0.01n	80200
SP217.T3.712.1	90	0.17014	0	0.01n	1750
SP215.T3.713.1	83	0.17003	10	0.01n	2462850
SP215.T3.714.1	91	0.16970	0	0.01n	0
SP198.T3.715.1	84	0.17086	10	0.01n	19089250
SP198.T3.716.1	92	0.17292	0	0.01n	99850
SP140.T3.717.1	85	0.17009	10	0.01n	2411800
SP140.T3.718.1	93	0.17060	0	0.01n	28300
SP203.T3.719.1	86	0.16888	10	0.01n	19265600
SP203.T3.720.1	94	0.17163	0	0.01n	133700
SP29.T3.721.1	87	0.16826	10	0.01n	171150
SP29.T3.722.1	95	0.17004	0	0.01n	0
SP161.T3.723.1	88	0.17083	10	0.01n	192250
SP161.T3.724.1	96	0.17086	0	0.01n	20400
SP137.T3.725.1	89	0.16942	10	0.01n	7893050
SP137.T3.726.1	97	0.17104	0	0.01n	800

n = nominal weight

Summary file name = BATCH17.RES

Filename	Dose kGy	Sample mass (mg)	TL 250-260'C cps
SP217.T3.807.1	10	3.60	411
SP217.T3.808.1	0	4.46	17
SP215.T3.809.1	10	2.71	344
SP215.T3.810.1	0	1.53	33
SP198.T3.811.1	10	1.63	1867
SP198.T3.812.1	0	1.08	798
SP140.T3.813.1	10	2.38	1808
SP140.T3.814.1	0	3.04	42
SP203.T3.815.1	10	1.67	373995
SP203.T3.816.1	0	2.39	74
SP29.T3.817.1	10	2.24	880
SP29.T3.818.1	0	3.54	251
SP161.T3.819.1	10	4.13	1976
SP161.T3.820.1	0	3.92	90
SP137.T3.821.1	10	3.59	1347
SP137.T3.822.1	0	3.37	303